AD NUMBER

AD830433

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; JUL 1958. Other requests shall be referred to Space and Missile Systems Organization, Attn: SMSD, Los Angeles, CA 90045.

AUTHORITY

SAMSO ltr dtd 28 Feb 1972

UNCLASSIFIED

INVESTIGATING COMMITTEE REPORT
TEST STAND S2, RUN S2-212-B4-01

SYCAMORE TEST BASE

COPY NUMBER 34

July 1958

SECURITY NOTICE

This document contains information affecting the national defense of the United States with in the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

[redacted]

FOREWORD

This document has been prepared under the direction of the Steering Committee for the Investigation of Test Stand S2, Run S2-212-B4-01, and represents the common agreement of the participating agencies.

K. E. Newton, Chairman
Chief, Test Conductor
Convair(Astronautics)
Sycamore Test Base

J. W. Wimberley
Representative in Charge
Rocketdyne Field Service
Convair (Astronautics)

P. T. Gardner
Base Manager
Convair (Astronautics)
Sycamore Test Base

for R. D. Raney
Chief Test Site Branch
Air Force Quality Control
Sycamore Test Base

W. W. Withee
Asst. Chief Engineer Test
Convair (Astronautics)

D. B. Jacobs
R-W Sycamore Representative
BMD/R-W Field Office

G. L. Armstrong
Project Office
Convair (Astronautics)

B. J. McCarroll, Major, USAF
Chief, AFBMD Field Office
Convair (Astronautics)

[redacted]

TABLE OF CONTENTS

[redacted]

INVESTIGATION COMMITTEE ORGANIZATION

1) STEERING COMMITTEE

K. E. Newton, Chairman, CV
Capt. J. Houston, AFBMD
D. B. Jacobs, R-W
J. W. Wimberley, Rocketdyne
R. D. Raney, AFQC

2) INVESTIGATION BOARD

P. J. Lynch, Asst. Chief Engr. Test
P. T. Gardner, Sycamore Base Manager
G. L. Armstrong, Project Office
Ray Clever, Contract Administration
C. L. Hartshorn, Plant Engineering
E. E. Riley, Security Investigator
J. S. Curtis, Chief of Inspection, Sycamore
E. J. Huntsman, Chief of Operations Support, Sycamore
R. H. Moore, Safety Engr., Sycamore

3) DOCUMENTATION

L. W. Stirling, Chairman, CV
Capt. J. Houston, AFBMD
A. J. Blecker, NAA

4) HARDWARE INVESTIGATION

E. R. McFadden, Chairman, CV
F. Lane, R-W
E. H. Blaser, NAA
G. W. Oetkem, AFQC

5) INSPECTION

J. Curtis, Chairman, CV
T. B. Tracey, NAA
T. A. Matera, CV
G. W. Oetkem, AFQC

6) DATA INVESTIGATION

C. L. Frasher, Chairman, CV
D. B. Jacobs, R-W
H. L. Conrad, NAA
B. J. Wierzbicki, CV

1.0 INTRODUCTION

1.1 An explosion occurred at Sycamore Test Stand S-2 on 18 June 1958 during static firing test S2-212-B4-01 (Run 212) on Missile 1B. No personnel were injured. Extensive hardware damage sustained by the following major components necessitated their removal and replacement: Booster Engine, Sustainer Engine, that portion of the Vernier engine contained within the thrust section. The jettisonable thrust section required repair. A preliminary investigation report was issued 20 June 1958.

1.2 In compliance with Convair DSP 1-29 an investigation was conducted to determine:

1) The cause of the explosion
2) A means to prevent recurrence
3) Extent of damage
4) A course of action which would provide the least interruption to the "B" series test program.

1.3 The cause of the explosion has been determined. To prevent recurrence, recommendations have been proposed and corrective action has been taken. The missile was removed from the stand and transported to San Diego Plant Number 1 on 27 June. Repairs and replacements were effected by Sycamore engineers and technicians under the provisions of Convair Cost Proposal 758-61, "Restoration of missile 1B and related TGSE at Sycamore Stand S-2 to Test Configuration," dated 9 July 1958. The missile was repaired and returned to Sycamore on 9 July.

1.4 The preceeding page presents the membership of the Steering Committee, the Investigation Board and the Sub-Committees responsible for the compilation and documentation of this report.

2.0 TEST CONDITIONS

2.1 Run S2-212-B4-01 (Run 212) was the fourth attempt to accomplish the fourth scheduled test on Missile 1B. The three previous attempts were prematurely terminated as follows:

2.1.1 Run S2-209-B4-01 (Run 209) was terminated, after 1.18 seconds, by the Sustainer overspeed control circuit.

2.1.2 Run S2-210-B4-01 (Run 210) was terminated, after 3.4 seconds, by a manual cutoff when missile LO_2 tank pressure fell below Redline limits due to failure of a solenoid operated check valve in the Airborne He bottle charge line.

2.1.3 Run S2-211-B4-01 (Run 211) was terminated, after 1.1 seconds, by the Sustainer overspeed control circuit.

2.2 Runs S2-203-A2-01 and S2-205-A2-01 in the first block of the 1B test series were also prematurely terminated by the Sustainer overspeed control circuit. Since recorded engine parameters reflected no indication of turbine overspeed in any of the four instances of overspeed cutoff, it was resolved that these cutoffs were due to overspeed trip malfunction. In order to prevent a recurrence in Run 212, the overspeed control circuit was disconnected at the engine relay box. Turbine speed was monitored on a Brown recorder and the Sustainer LO_2 Reference Regulator setting was reduced to 785 PSIG from 810 PSIG in order to decrease the rate of thrust build-up in the event it became necessary to execute a manual cutoff.

2.3 Run 212 scheduled engine durations were Booster 100 seconds, Sustainer 194 seconds and Vernier 220.5 seconds.

2.4 The primary objectives of Run 212 were:

(1) Analyze the performance of the MA-1 Propulsion System during a long duration three stage engine firing with programmed gimbaling in each stage, (2) Analyze the operation of the Airborne Pneumatic system, (3) Develop Series "B" tanking and starting techniques and, (4) Develop procedures for systems checkouts and "B" series static firing in support of operations at AFMTC. For detailed description of test objectives see General Captive Test Plan No. ZB-7-036, Revision B.

2.5 Booster and Sustainer staging were to have been initiated by the Flight Programmer. Missile hydraulic requirements were to have been supplied by the Airborne System. Missile pneumatics were to have been supplied by the Airborne system with continuous replenishment from the facility helium system. However, switchover to Airborne engine control pneumatics did not occur due to premature cutoff. Missile electrical requirements were to have been supplied by the Airborne battery and inverter, however, they were supplied from the ground system because Airborne battery voltage was too high.

2.6 Run 212 was performed in accordance with "Run 4 countdown 17 June 1958." This countdown deviated from the countdown signed off by the design groups on 3 June 1958 as follows:

2.6.1 The fuel tanking level of 10,761 gallons was changed to 10,766 gallons in order to comply with report AA-E-130, Propellant loading for the XSM-65-B3 Missile.

2.6.2 Due to failure of the PU manometers LO_2 was dumped to missile station 519, according to Vibrotron readings, instead of to a computor comparator null error indication.

2.6.3 Because the allowable temperature at the LO_2 breakaway valve (P1021T) was exceeded during Runs 209 and 210, the 60 second time count was eliminated. All the items in the 60 second count were re-sequenced to move the LO_2 dump to within 30 seconds of major command "Vernier Squibs Fire" (Time Zero). Commands were called out by the Test Conductor and a 15 second time count was called out between commands "Depress Start Switch" and "Vernier Squibs Fire."

2.6.4 Run 4 countdown dated 17 June 1958 is included in this report as Appendix A. The only deviation from this countdown during Run 212 was that missile power was supplied from external because the internal missile DC power system malfunctioned.

3.0 TEST PREPARATIONS

3.1 X-1 Day Preparations

X-1 day preparations began at 2400 17 June and were completed at approximately 1400 18 June. Fuel remained on board the missile from the previous day's run attempt and the missile was in a state of readiness which considerably reduced the preparations required.

0020 - The fuel tank was topped off to station 953 as indicated by the sight gage. The flow total registered 80 gallons of fuel tanked.

1200 - Booster and Sustainer engines were Trichlor flushed and the Boosters were filled with lithium chloride.

1300-1400 - Igniters installed.

3.2 Precount Operations

1408 - Precount operations started.

1451 - An official hold was called. Inspection of the thrust section revealed grease around B2 thrust chamber gimbal mount. The area was cleaned & operations resumed. Total hold time was 14 minutes.

1510-1525 - Precount operations were delayed to complete the installation of the flexible firewall.

1530 - Transfer of LN_2 to the missile shrouds started.

1556 - All shrouds were filled and the LN_2 flow control valves had cycled.

1556 - Precount operations were completed. Predicted duration for this section was 60 minutes; actual elapsed time was 108 minutes.

3.3 Countdown Operations

1600 - Countdown operations began and the area was placed in Condition Red.

1601 - Booster and Sustainer hydraulic systems set up started. The Sustainer missile return pressure was reported to be 7 psig. A hold was called at 1602 to send a mechanic to the area to check the return gage on the Sustainer hydraulic cart. It indicated 6-8 psig. By use of the hand pump in the cart, the pressure was increased to 33 psig. It then dropped slightly, stabilizing at about 28 psig. Countdown operations resumed at 1608 after a total hold of 7 minutes.

3.3 (Cont'd)

1608 - Missile bottle pressurization commenced. Instrumentation reported a bottle pressure of 3000 psig at 1611.

1609 - Missile pressurization Sequence 2 was initiated.

1609 - LO_2 tank and facility chilldown commenced.

1616 - Pumps LA & LB were started. LO_2 tanking was switched to a separate communications channel and LO_2 was tanked according to the support requirements of missile 3B.

1633 - Missile pressurization Sequence 3 was initiated.

1637 - Missile power was switched to internal. Upon switching DC, missile AC voltage and frequency increased rapidly out of limits and the DC internal voltage was reported to be approximately 34 volts. It was decided to continue the run on external power. Post run investigation of records revealed that the missile battery had not been pre-loaded by the factory.

1637 - At approximately X-57 seconds, LO_2 was dumped for 27 seconds to missile stateion 519.

1638 - Booster and Sustainer ignition was initiated. Immediately after ignition, cutoff occurred and fire was reported in the thrust section. All firex systems were turned on and the fire quickly extinguished. Booster Ground Bus Power and Booster Engine Control pressure was lost. All power to the missile was secured.

1642 - CO_2 system secured.

1642 - LO_2 detanking commenced.

1655 - Fire was reported again in the thrust section. The CO_2 system was turned on and the fire was quickly extinguished.

1657 - The CO_2 system was again secured.

1713 - LO_2 detanking was completed and the firex system was secured.

1715 - An attempt was made to detank fuel but the tank observers reported heavy leakage from the thrust section and it was decided to leave the fuel in the missile until an investigation could be made. Upon reporting to the area, the Stand Engineer reported heavy thrust section damage and fuel leaking downstream of the Sustainer pre-valve. After further investigation of damage to the missile, the Sustainer pre-valve was kept closed by removing the opening control pressure line, and the fuel was detanked.

3.3 (Cont'd)

1745 - All systems were secured. Predicted durations of this section was 80 minutes; actual elapsed time was 105 minutes.

3.4 Safety Precautions

Safety Engineer Report -- Sycamore Test Site

3.4.1 The X-1 day and precount preparations were accomplished with proper safety precautions. Supervision in all sections carried out their shceduled work assignments with proper safety equipment. Coordination between Stand area and Blockhouse key personnel was satisfactory in all phases of countdown.

3.4.2 During the attempted firing all personnel assigned to specified tasks were at their stations and in direct contact with the Test Conductor's area. They carried cut these tasks in an orderly and well ccordinated manner.

3.4.3 Immediately after the accidnet exceptional team effort was shown by all personnel. I believe it was this team coordinated effort that held the damage to this limited extent.

S/_____
R. H. Moore
Safety Engineer

4.0 SUMMARY OF TEST OBSERVATIONS

4.1 The following is a summary of visual observations made before, during and after the explosion based on written testimony of Blockhouse and Tank Observers. Where these observations were not substantiated by test data a qualifying comment is added.

4.1.1 V2 Ignition appeared normal. V1 ignition appeared fuel rich and rough. However, test data does not substantiate a rough fuel rich V1 ignition.

4.1.2 Booster and Sustainer ignition appeared short. A puff of smoke was immediately noticed to come from the Sustainer engine and fire broke out, concentrated primarily in the region of the Sustainer and B1 exhausts. A spreading fire was seen near the V1 flame deflector which became entrained in the flames bellowing up from the lower thrust section.

Review of photographic coverage and hardware investigation reveals no indication of fire in the region of the V1 thrust chambers.

4.1.3 Fire was reported by observers within 7 seconds of Vernier ignition and was also noted on the Blockhouse television display at this time. CO_2 firex and launcher coolant systems came on and the fire was promptly extinguished. CO_2 was turned off and the firex was left on.

4.1.4 A second flare up was observed and promptly extinguished by again turning on CO_2. Fire and launcher coolant systems remained on throughout the fire.

4.1.5 CO_2 was turned off and detanking of LO_2 was accomplished without incident. The stand engineer and a fireman were sent out to inspect the missile. Firex and launcher coolant systems were turned off.

4.1.6 When the fuel prevalves were actuated to detank fuel, considerable fuel appeared to be coming from the Sustainer Gas Generator exhaust. Detanking of fuel was delayed until the Sustainer fuel prevalve control could be disconnected.

4.1.7 Post run hardware examination revealed that the Sustainer Gas Generator Fuel blade valve remained closed throughout the run and that the fuel blade valve seals were intact. It was also determined that the fuel volute of the Sustainer turbopump contained a crack approximately 3/8" X 10". It is therefore believed that the fuel reported by the observer as leaking from the Gas Generator exhaust was actually coming from the cracks in the fuel turbopump volute.

4.1.8 Verbatim testimony of the observers is presented as Appendix B to this report.

5.0 TEST DATA

5.1 The following is a chronological presentation of significant Run 212 data analysis as pertains to the cause and history of the thrust section explosion which occurred during this run. The time at which each event occurred is stated in seconds with relation to Vernier Igniters Firing (Zero Time). Appendix C of this report gives a detailed presentation of the analysis of all data recorded during Run 212. Appendix D presents a detailed chronological history of significant data. (Appendices C and D follow Section 7 of this report).

5.2 Chronological History of Major Events:

(Zero time is Vernier Igniters firing)

TIME (SECONDS)	EVENT
-467	Sustainer Gas Generator discharge temperature indicates a decline from 117 Deg. F to negative peg. The time at which this decline took place is unknown as the recorder was not turned on until -467 seconds.
-299.83	Commenced pressurization Sequence III which indicates the LO_2 tanking was completed.
-149.13 to -90	During this period, three unsuccessfull attempts were made to switch electrical power to internal and the run proceeded on external power.
-61	Indication of continuous LO_2 flow of approximately 3 lbs/min to the Sustainer Gas Generator. The time the flow started is unknown as the CEC recorder No. 8146 was not turned on until this time.
-38.13	LO_2 duct pressure activity indicating fill and drain valve closing at completion of LO_2 dumping.
-13.24 to -1384	Vernier start sequence initiated and start tanks pressurized resulting in transient Vernier and Gas Generator propellant flows due to displacement of gas. Sustainer Gas Generator LO_2 flow increases to .5 lbs/minute (See Graphs 6, 8 & 10)
0	Vernier igniter squibs signaled to fire.
-.64 to 0.83	Vernier propellant valves signaled to open, propellant and chamber pressures indicate combustion occurs (See Graphs 1, 2 & 6).
-0.84 to 0.89	Sustainer gas generator fuel flowmeter indicates low amplitude signal or noise which may indicate flow to gas generator or igniter fuel valve. (See Graph 9).

5-2 (Cont'd)

TIME	EVENT
1.81 to 1.82	Booster and Sustainer LO_2 and igniter fuel valves energized to open indicating main igniters have fired.
1.87 to 2.22	Booster and Sustainer main LO_2 valves open; pressures and flows indicate igniter LO_2 and fuel flow (See Appendix D). Sustainer gas generator fuel flow indication may be flow to gas generator. (See Graph 9).
2.30	Ignition complete indicates ignition detection signaled gas generator igniters to fire.
2.31 to 2.37	Many measurements indicate transients or loss of signal. (See Appendix E). Booster and Vernier sequence control power is lost indicating disruption of electrical circuits. Loss of ground automatically initiates cutoff. Load cells and launcher strains indicate shock of significant magnitude (See Graphs 3 & 5). Most accurate time correlation is by measurements recorded on oscillograph which indicate shock originated in Sustainer section. Sustainer fuel flow starts at 130 lbs/sec. indicating system ruptured. (See Graph 7).
2.38 to 2.47	Engine compartment temperature starts to increase though not abnormally (See Graph 11). Other measurements indicate transients and loss of signal.
2.48 to 2.53	Vernier pressures indicate propellant valves closed and combustion ceasing.
2.65	Sustainer HSV closed by microswitch indication but still partially open by angular position transducer.
2.74 to 3.01	Many measurements still erratic and losing signals.
3.27 to 3.31	Missile movement, Sustainer fuel duct pressure, activity and engine compartment temperature and launcher strains indicate another shock and probable start of major fire (See Graph 5).
3.42	Sustainer HSV confirmed to be closed by angular position, transducer. This indicates electrical control circuit disruption since the open signal and control hydraulic pressure were still present.
5.08 to 5.21	Engine electrical control circuits de-energized by cutoff; propellant start tanks vent.

5.2 (Cont'd)

TIME	EVENT
7.87 to 7.97	Missile movement and pneumatic pressure transients indicate another shock or airborne pressure supply transient.
13.36 to 17.87	Propellant pre-valves indicate closed and Sustainer fuel flow ceases (See Graph 7)
20.67 to 30	Thrust section temperatures reach maximum and begin to decrease towards ambient (See Graphs 11 & 14) indicating fire decreasing.
48.87	Fuel tank pressure indicates restep to Sequence II.
120	Thrust section temperatures at or near ambient indicating fire out. (See Graphs 11 & 14).

5.3 Analysis of Results

5.3.1 Propulsion System:

5.3.1.1 The Sustainer gas generator temperature (Graph 19) and lox flowmeter (Graph 8) indicate lox flowing into the combustor prior to start. Indicated fuel flow to the Sustainer gas generator (Graph 9) is suspected as signal noise because of the low amplitude, non-sinusoidal trace.

5.3.1.2 Vernier ignition and start tank fed operation were similar to previous runs. (Graphs 1, 2 & 6). Main engine ignition was completed but mainstage was not achieved due to lack of gas generator igniter links break signal. Without the GG igniter links break signal the gas generators propellant blade valves and main fuel valves were not signalled to open. Vernier propellant and main lox valve closed, apparently due to loss of electrical control power as opening signals were still transmitted until 2.78 sec. after ignition was completed. Cutoff vented the start tanks. Sustainer fuel flowed for 13 sec. from ignition complete until propellant pre-valves closed, indicating that the Sustainer fuel system was ruptured as there was no indication of fuel valves opening.

5.3.1.3 Analysis of records from the preceeding firing, Run 211, show a pronounced temperature surge in the Sustainer Gas Generator immediately after cutoff. (See Graph 20). Temperature rose from approximately 1000° at cutoff to 1800° 0.1 second later. The recorder pegged at 1820°F for 0.5 seconds, fell to 1450°F, spiked to 1680°F, and then declined normally. After the run the transducer was inspected and showed evidence of being burned and was replaced prior to Run S2-212. This measurement has not been reliable in the past, and the above temperatures can be considered approximate only, in view of the damage

5.3.1.3 (Cont'd)
suffered by the transducer. However, it is reasonable to conclude that a large and relatively prolonged temperature surge occurred immediately after cutoff. This surge probably caused the failure of the Gas Generator LO_2 seals. It represents the only significant deviation from normal run conditions, disregarding Sustainer Overspeed Trip activation, which was observed in Run 211 data.

5.3.1.4 The Sustainer Gas Generator was disassembled at Sycamore. The blade valves were found in the closed position. The LO_2 seals were shattered. The fuel seals were intact (See photographs 17 through 28).

5.3.1.5 After examination of the Sustainer Gas Generator at Sycamore the unit was released to Rocketdyne for examination at Canoga Park. A detailed examination of individual components was conducted. It was discovered that the injector head was bulged slightly downward (.068 inches maximum). The LO_2 manifold was found to be slightly bulged upward and outward (.020 inches). (See Appendix F for Rocketdyne reports).

5.3.2 Electrical System:

After three attempts to switch to internal electrical power, the electrical power remained on external and was normal until 2.36 sec. when propulsion control power (E1027V) indication was lost; missile systems power remained normal for remainder of the test.

5.3.3 Pneumatic System

Propellant tank pressures were normal throughout the test. Fuel tank and lox regulator pressures reflect change to internal at approx. -31 sec, but temperatures do not reflect cold gas flow. Sustainer control pressure transient (@2.27 sec), indicates controls pressure switchover to internal .71 after this signal. Most measurements indicate signal loss or transients after ignition complete (2.30 sec.) as result of shock, fire, and disruption of instrument signal circuits. Indicated booster control pressure loss is a signal loss as LO_2 reference regulator still indicates pressure.

5.3.4 Hydraulic System

Ground supply maintained pressures satisfactorily.

5.3.5 Flight Control System

Engines were maintained in null position, autopilot program was not initiated as main engines complete signal was not transmitted.

5.3.1.3 (Cont'd)
suffered by the transducer. However, it is reasonable to conclude that a large and relatively prolonged temperature surge occurred immediately after cutoff. This surge probably caused the failure of the Gas Generator LO_2 seals. It represents the only significant deviation from normal run conditions, disregarding Sustainer Overspeed Trip activation, which was observed in Run 211 data.

5.3.1.4 The Sustainer Gas Generator was disassembled at Sycamore. The blade valves were found in the closed position. The LO_2 seals were shattered. The fuel seals were intact (See photographs 17 through 28).

5.3.1.5 After examination of the Sustainer Gas Generator at Sycamore the unit was released to Rocketdyne for examination at Canoga Park. A detailed examination of individual components was conducted. It was discovered that the injector head was bulged slightly downward (.068 inches maximum). The LO_2 manifold was found to be slightly bulged upward and outward (.020 inches). (See Appendix F for Rocketdyne reports).

5.3.2 Electrical System:

After three attempts to switch to internal electrical power, the electrical power remained on external and was normal until 2.36 sec. when propulsion control power (E1027V) indication was lost; missile systems power remained normal for remainder of the test.

5.3.3 Pneumatic System

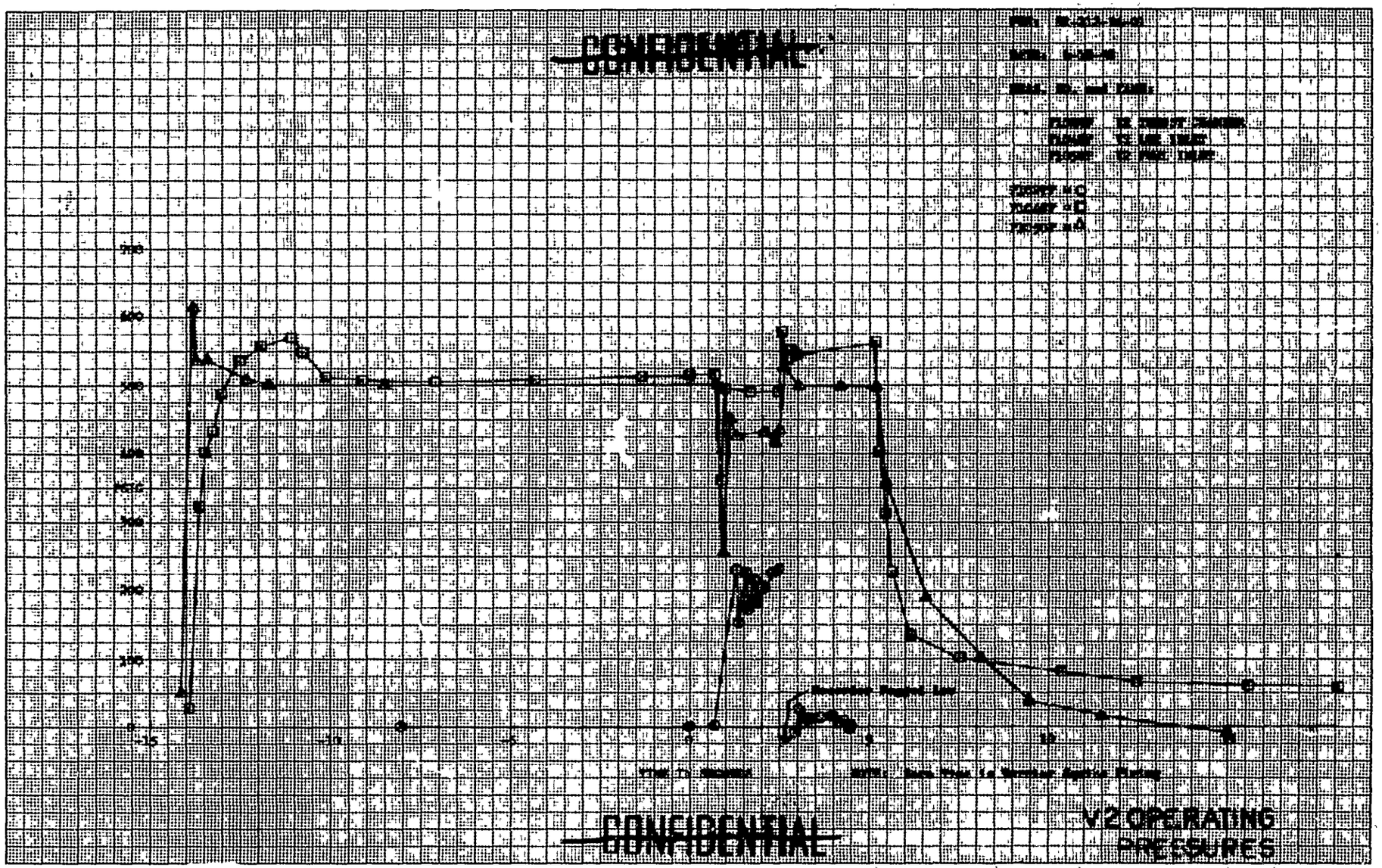
Propellant tank pressures were normal throughout the test. Fuel tank and lox regulator pressures reflect change to internal at approx. -31 sec, but temperatures do not reflect cold gas flow. Sustainer control pressure transient (@2.27 sec), indicates controls pressure switchover to internal .71 after this signal. Most measurements indicate signal loss or transients after ignition complete (2.30 sec.) as result of shock, fire, and disruption of instrument signal circuits. Indicated booster control pressure loss is a signal loss as LO_2 reference regulator still indicates pressure.

5.3.4 Hydraulic System

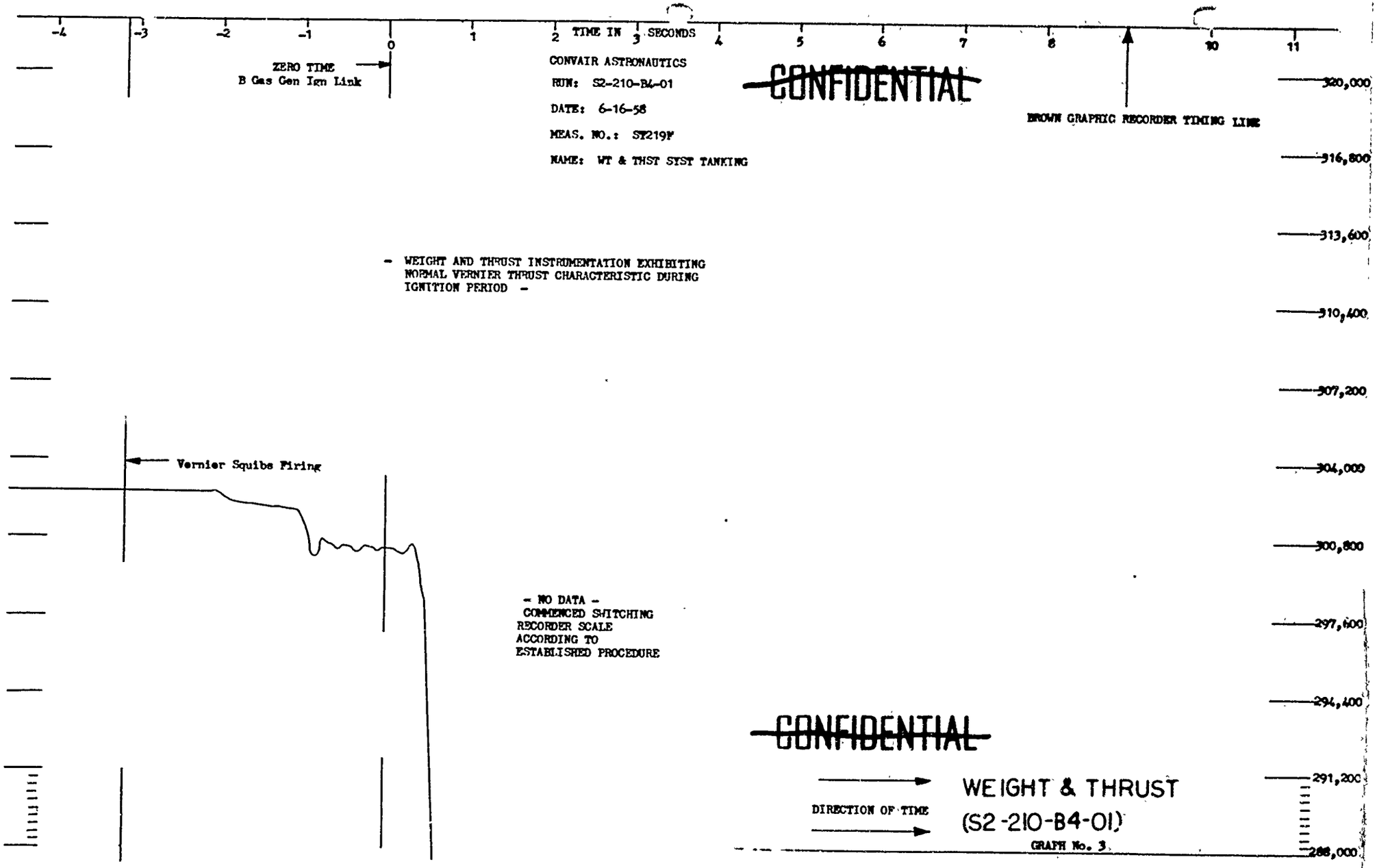
Ground supply maintained pressures satisfactorily.

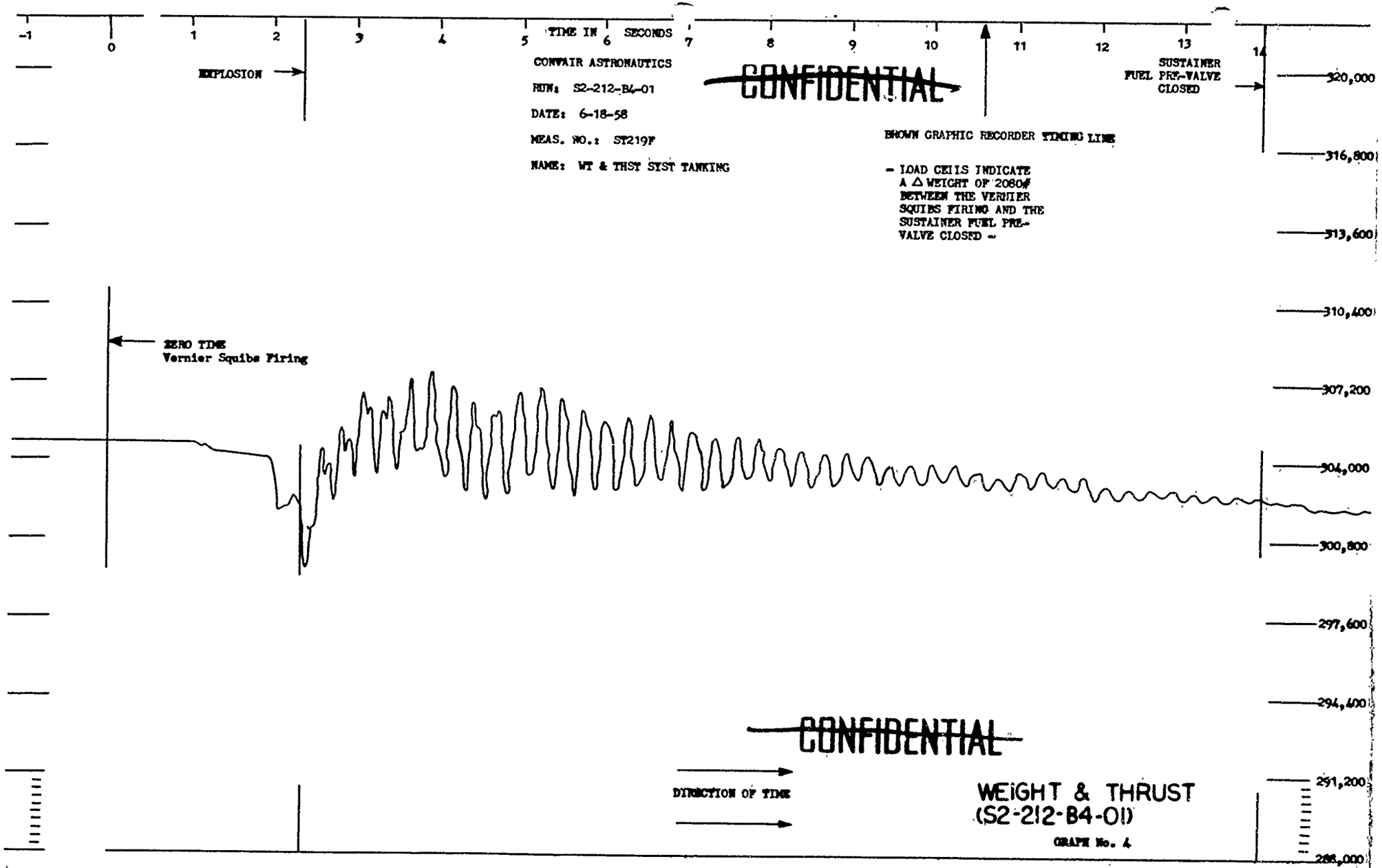
5.3.5 Flight Control System

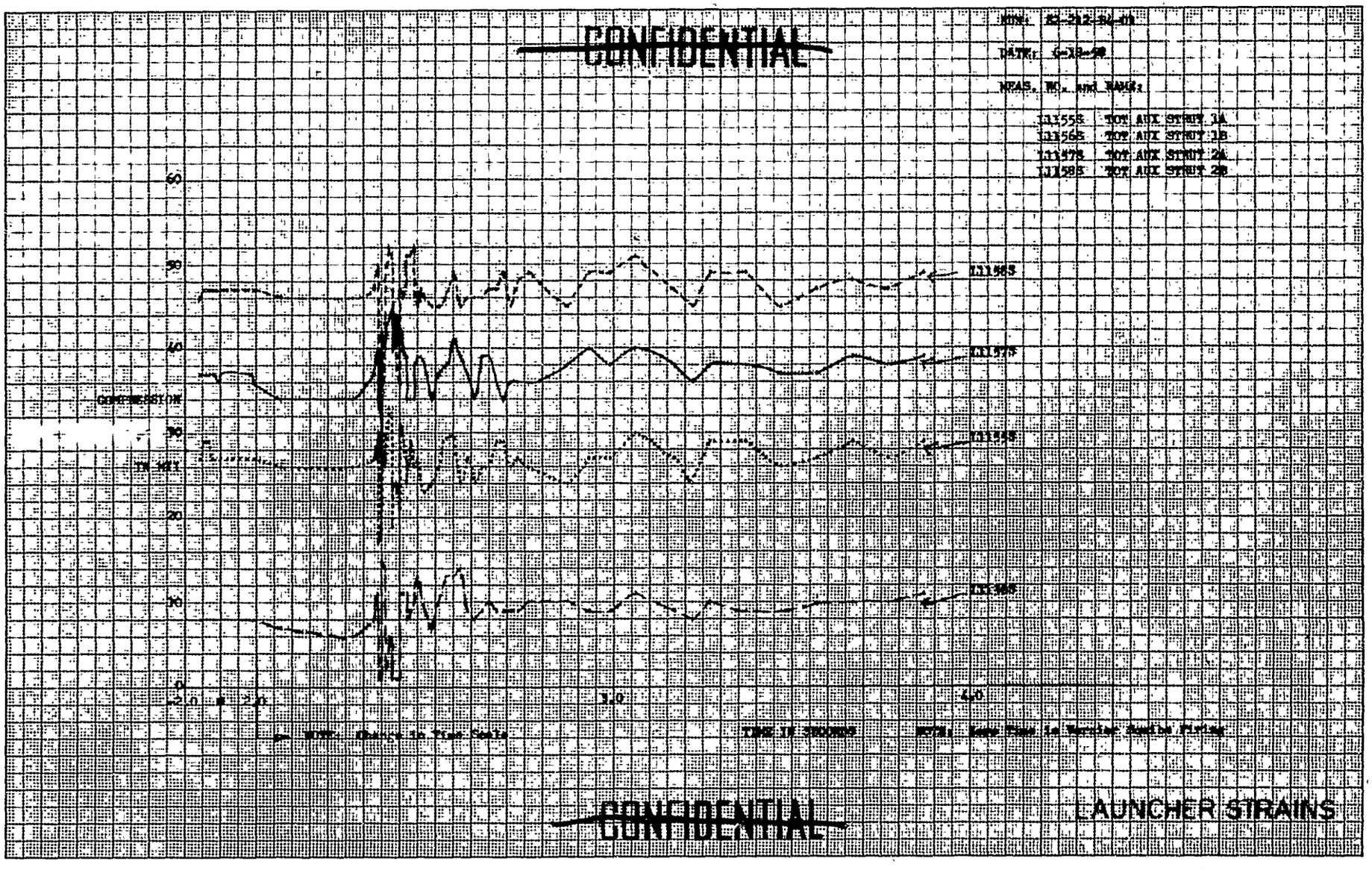
Engines were maintained in null position, autopilot program was not initiated as main engines complete signal was not transmitted.



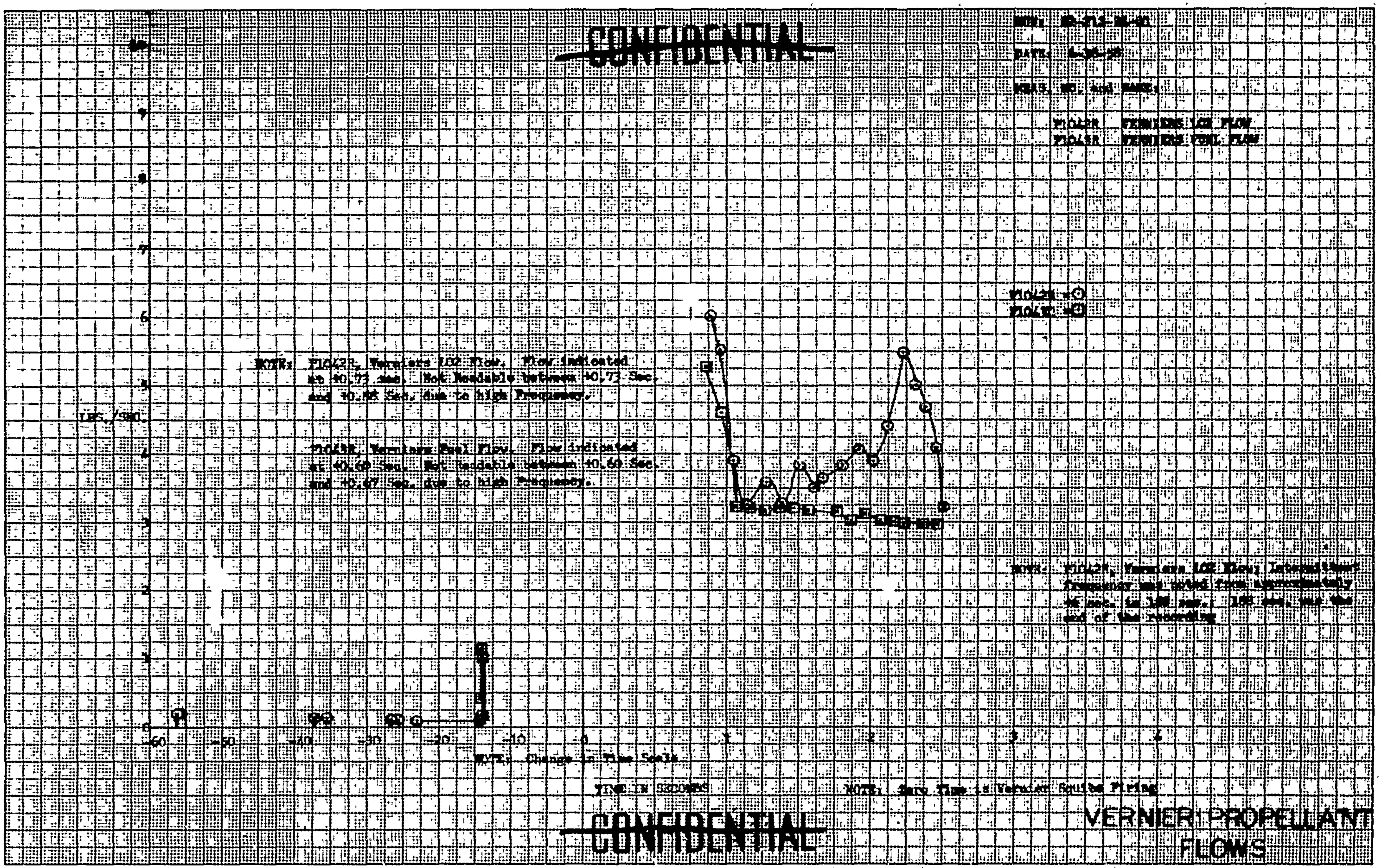
GRAPH No. 2


-4
-3
-2
-1
0
1
2
TIME IN SECONDS
3
4
5
6
7
8
10
11
ZERO TIME
B Gas Gen Ign Link
CONVAIR ASTRONAUTICS
RUN: S2-210-B4-01
DATE: 6-16-58
MEAS. NO.: ST219F
NAME: WT & THST SYST TANKING
CONFIDENTIAL
BROWN GRAPHIC RECORDER TIMING LINE
320,000
316,800
313,600
310,400
307,200
304,000
300,800
297,600
294,400
291,200
288,000
- WEIGHT AND THRUST INSTRUMENTATION EXHIBITING NORMAL VERNIER THRUST CHARACTERISTIC DURING IGNITION PERIOD -
Vernier Squibs Firing
- NO DATA - COMMENCED SWITCHING RECORDER SCALE ACCORDING TO ESTABLISHED PROCEDURE
CONFIDENTIAL
DIRECTION OF TIME
WEIGHT & THRUST
(S2-210-B4-01)
GRAPH No. 3

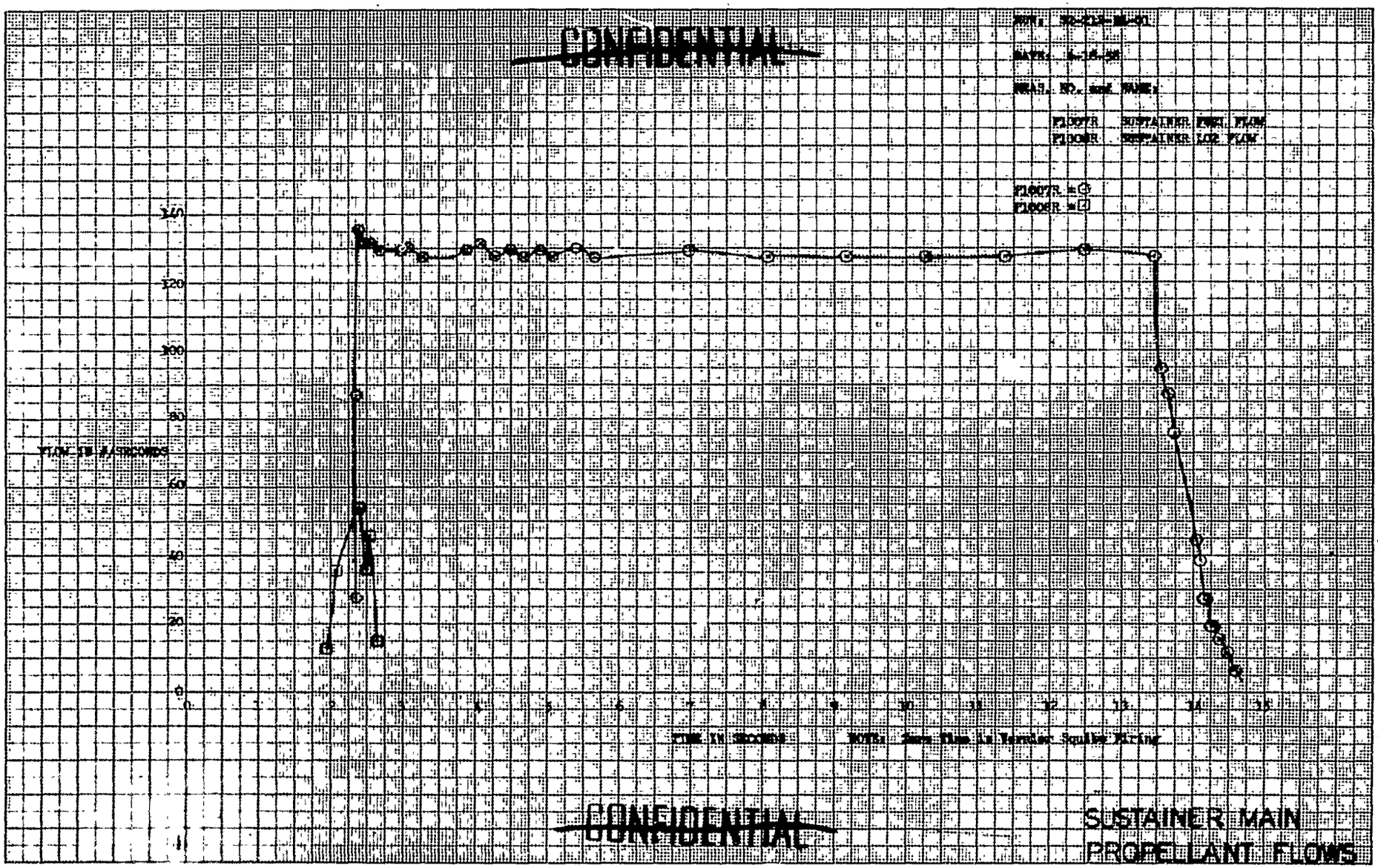

-1
0
1
2
3
4
5
TIME IN SECONDS
6
7
8
9
10
11
12
13
14
EXPLOSION
CONVAIR ASTRONAUTICS
RUN: S2-212-B4-01
DATE: 6-18-58
MEAS. NO.: ST219F
NAME: WT & THST SYST TANKING
CONFIDENTIAL
BROWN GRAPHIC RECORDER TIMING LINE
- LOAD CELLS INDICATE A Δ WEIGHT OF 2080# BETWEEN THE VERNIER SQUIBS FIRING AND THE SUSTAINER FUEL PRE-VALVE CLOSED -
SUSTAINER FUEL PRE-VALVE CLOSED
320,000
316,800
313,600
310,400
307,200
304,000
300,800
297,600
294,400
291,200
288,000
ZERO TIME
Vernier Squibs Firing
CONFIDENTIAL
DIRECTION OF TIME
WEIGHT & THRUST
(S2-212-B4-01)
GRAPH No. 4


CONFIDENTIAL
MISS. No. and NAME:
111555 TOP AUX STRUT 1A
111565 TOP AUX STRUT 1B
111575 TOP AUX STRUT 2A
111585 TOP AUX STRUT 2B
111565
111575
111555
111585
60
50
40
30
20
10
0
COMPRESSION
IN PSI
3.0
4.0
CONFIDENTIAL
AUNCHER STRAINS

GRAPH No. 5

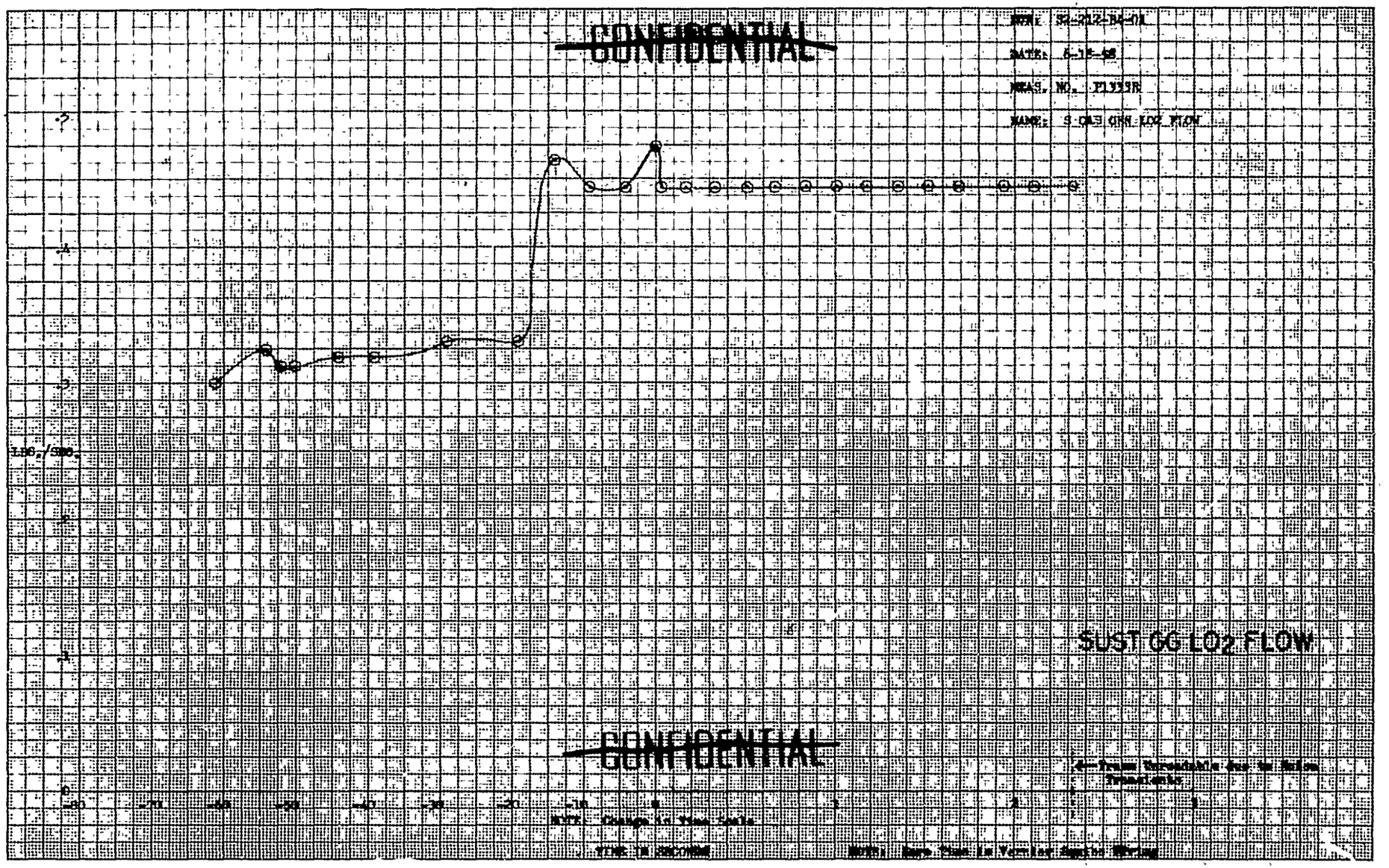

CONFIDENTIAL
MEAS. NO. and NAME:
F1042R VERNIERS LOX FLOW
F1043R VERNIERS FUEL FLOW
NOTE: F1042R, Verniers LO2 Flow. Flow indicated at +0.73 Sec. Not Readable between +0.73 Sec. and +0.88 Sec. due to high Frequency.
F1043R, Verniers Fuel Flow. Flow indicated at +0.60 Sec. Not Readable between +0.60 Sec. and +0.67 Sec. due to high Frequency.
LBS./SEC.
NOTE: Change in Time Scale
TIME IN SECONDS
CONFIDENTIAL
VERNIER PROPELLANT FLOWS

GRAPH No. 6


CONFIDENTIAL
P1007R SUSTAINER FUEL FLOW
P1008R SUSTAINER LOX FLOW
P1007R =
P1008R =
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
CONFIDENTIAL
SUSTAINER MAIN
PROPELLANT FLOWS

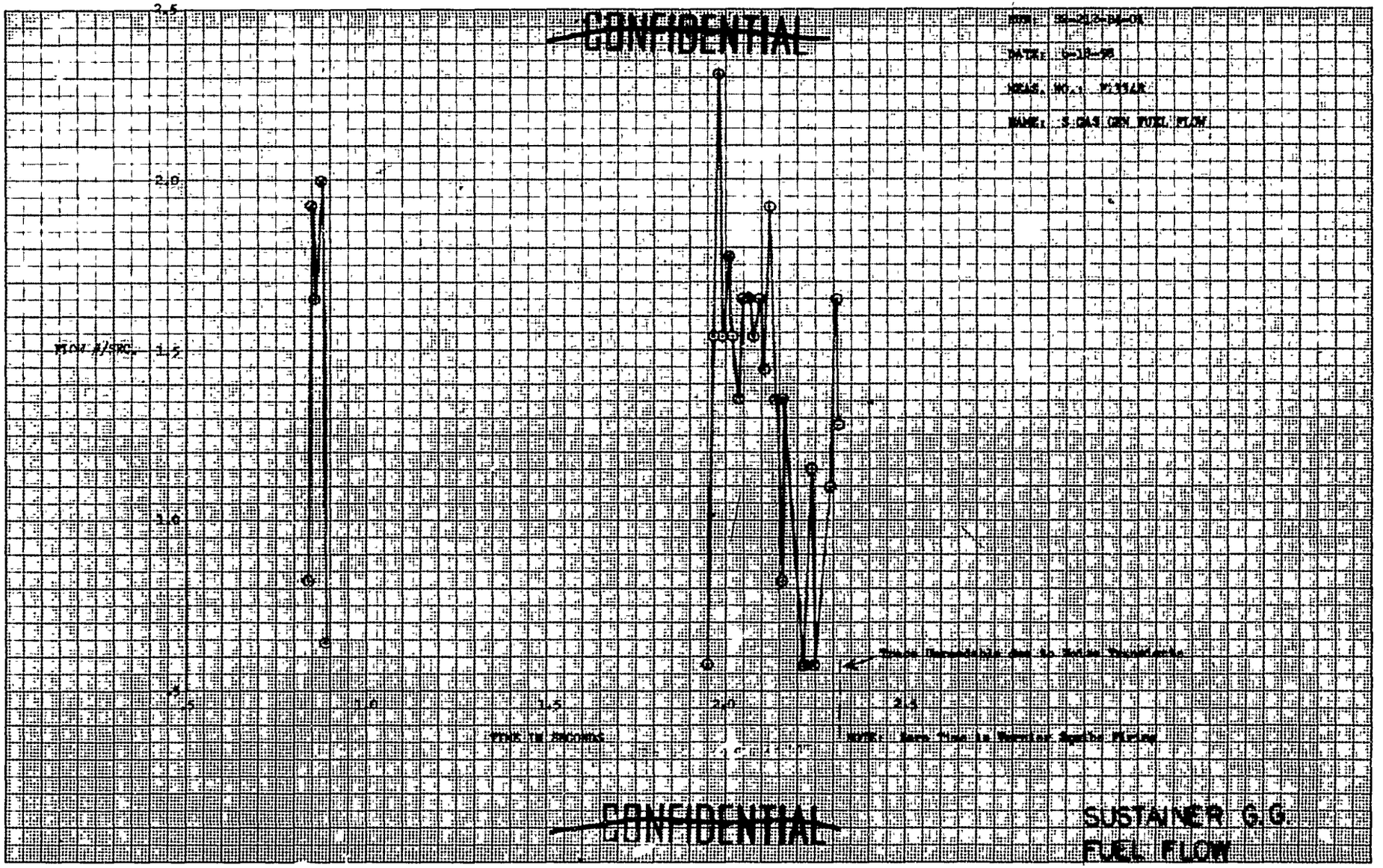
GRAPH No. 7

CONVAIR ASTRONAUTICS



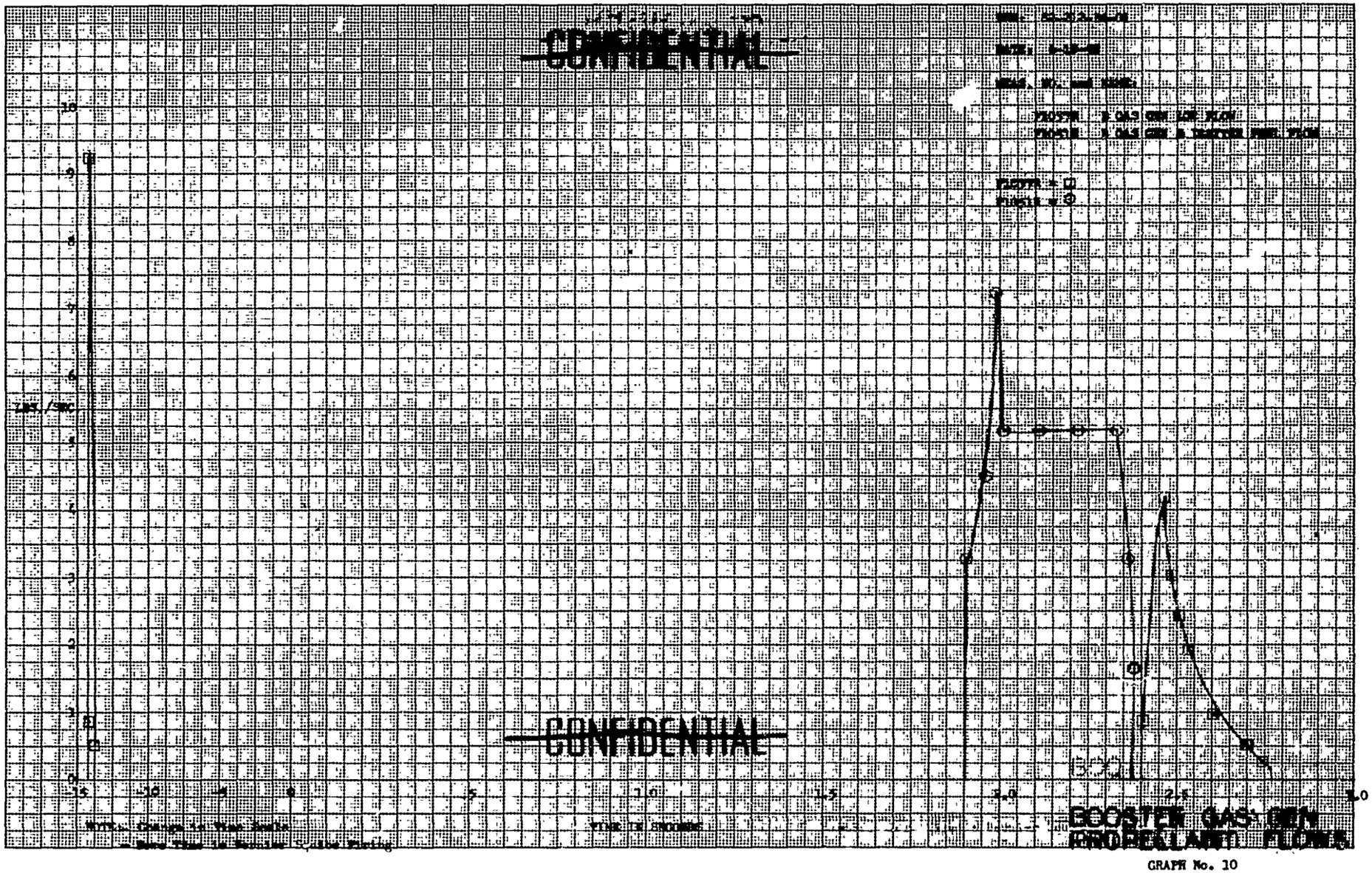
GRAPH No. 8

CONVAIR ASTRONAUTICS

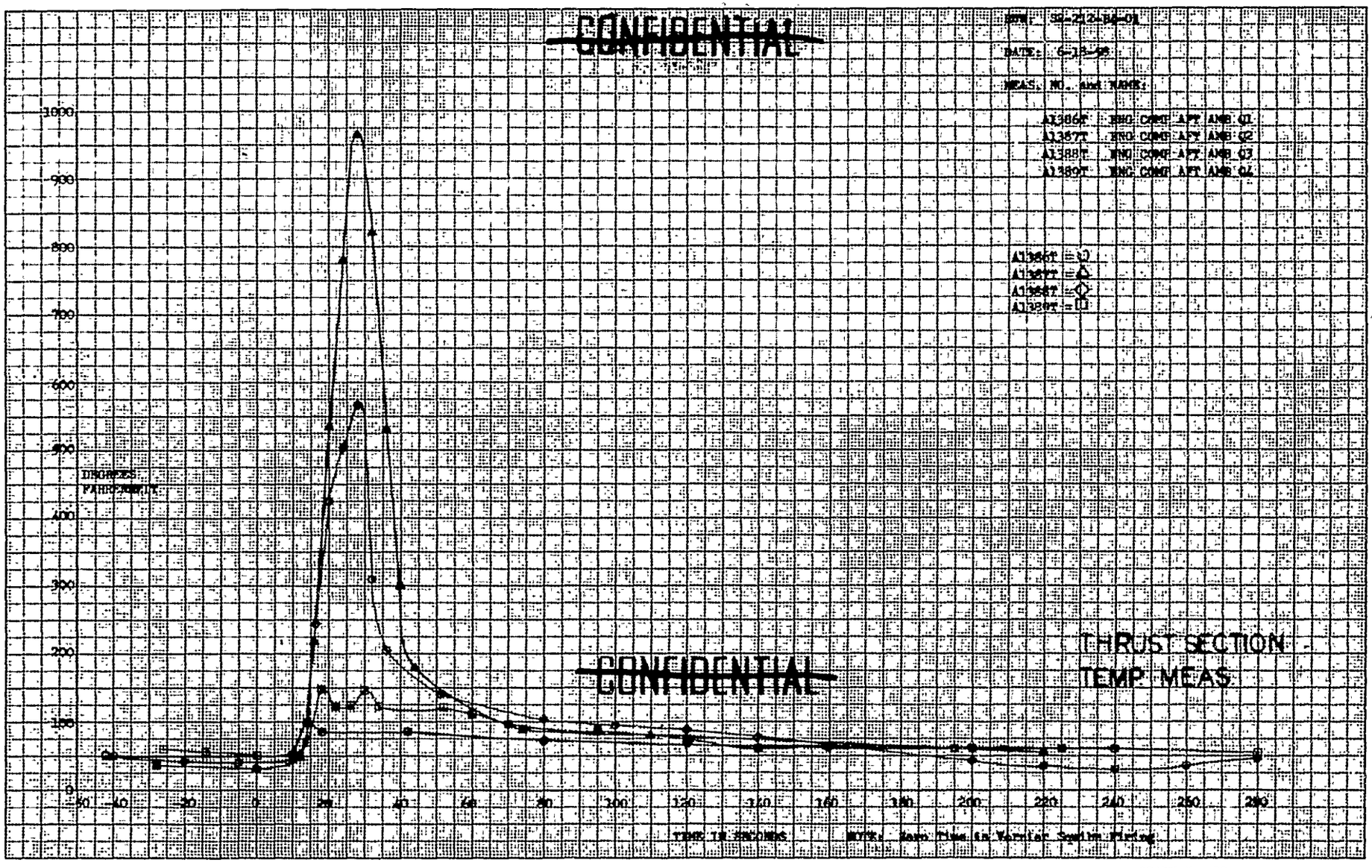


SUSTAINER G.G. FUEL FLOW

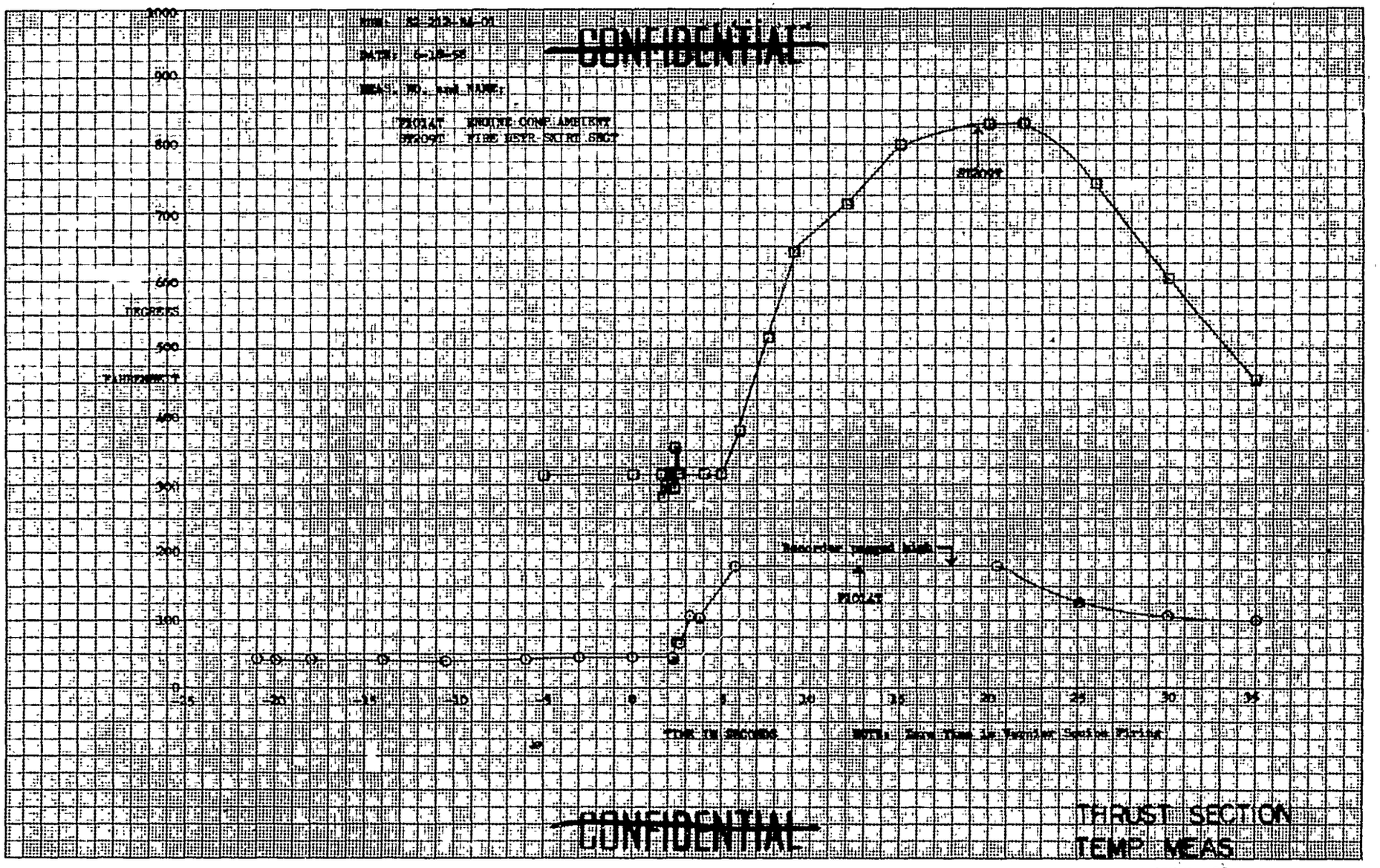
GRAPH No. 9


CONFIDENTIAL
CONFIDENTIAL
LBS./SEC.
TIME IN SECONDS
BOOSTER GAS GEN PROPELLANT FLOWS

GRAPH No. 10

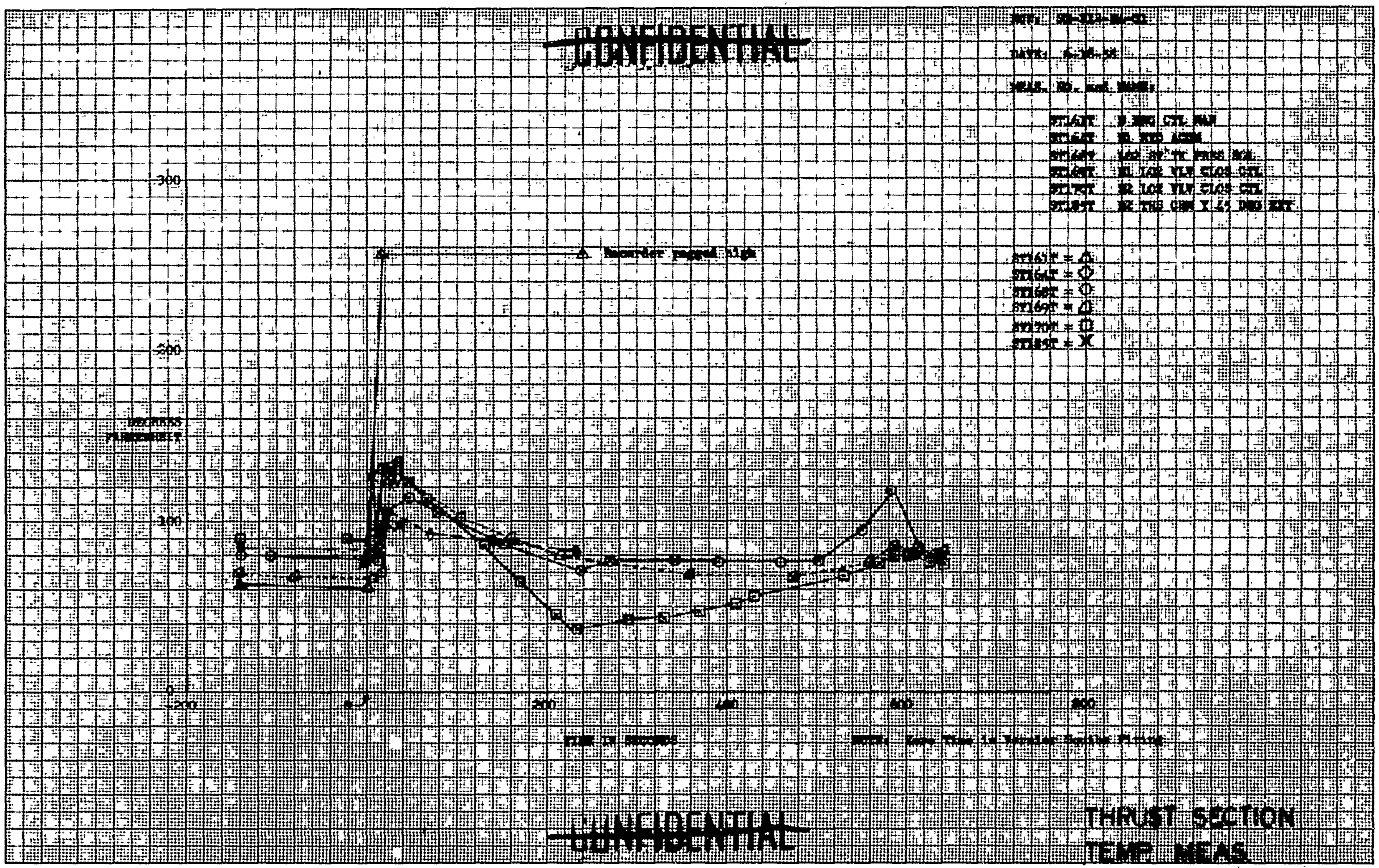

CONFIDENTIAL
RPT: SG-212-84-01
DATE: 6-15-58
MEAS. NO. and NAME:
A1386T RNO COMP AFT AMB Q1
A1387T RNO COMP AFT AMB Q2
A1388T RNO COMP AFT AMB Q3
A1389T RNO COMP AFT AMB Q4
A1386T = Q
A1387T = △
A1388T = ◇
A1389T = □
1000
900
800
700
600
500
400
300
200
100
0
DEGREES FAHRENHEIT
-50 -40 -30 0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
TIME IN SECONDS
NOTE: Zero Time is Vernier Engine Firing
CONFIDENTIAL
THRUST SECTION
TEMP MEAS

GRAPH No. 11

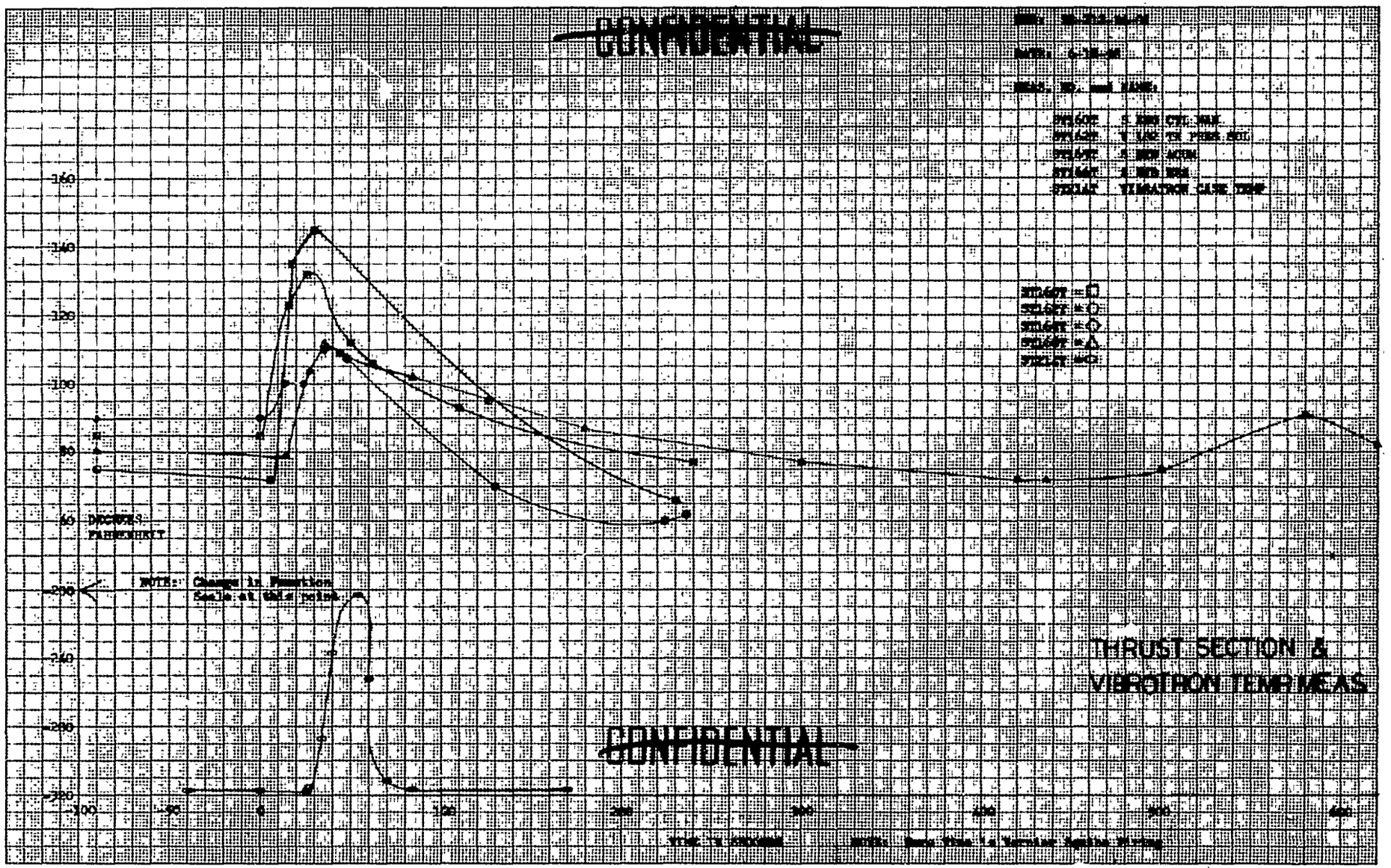

CONFIDENTIAL
DATE: 6-18-58
PROJAT ENGINE COMP AMBIENT
PROPT FIRE BYPR SKIRT SECT
1000
900
800
700
600
500
400
300
200
100
0
DEGREES
FAHRENHEIT
-40
-30
-20
-10
0
10
20
30
40
TIME IN SECONDS
PROJAT
CONFIDENTIAL
THRUST SECTION
TEMP MEAS

GRAPH No. 12

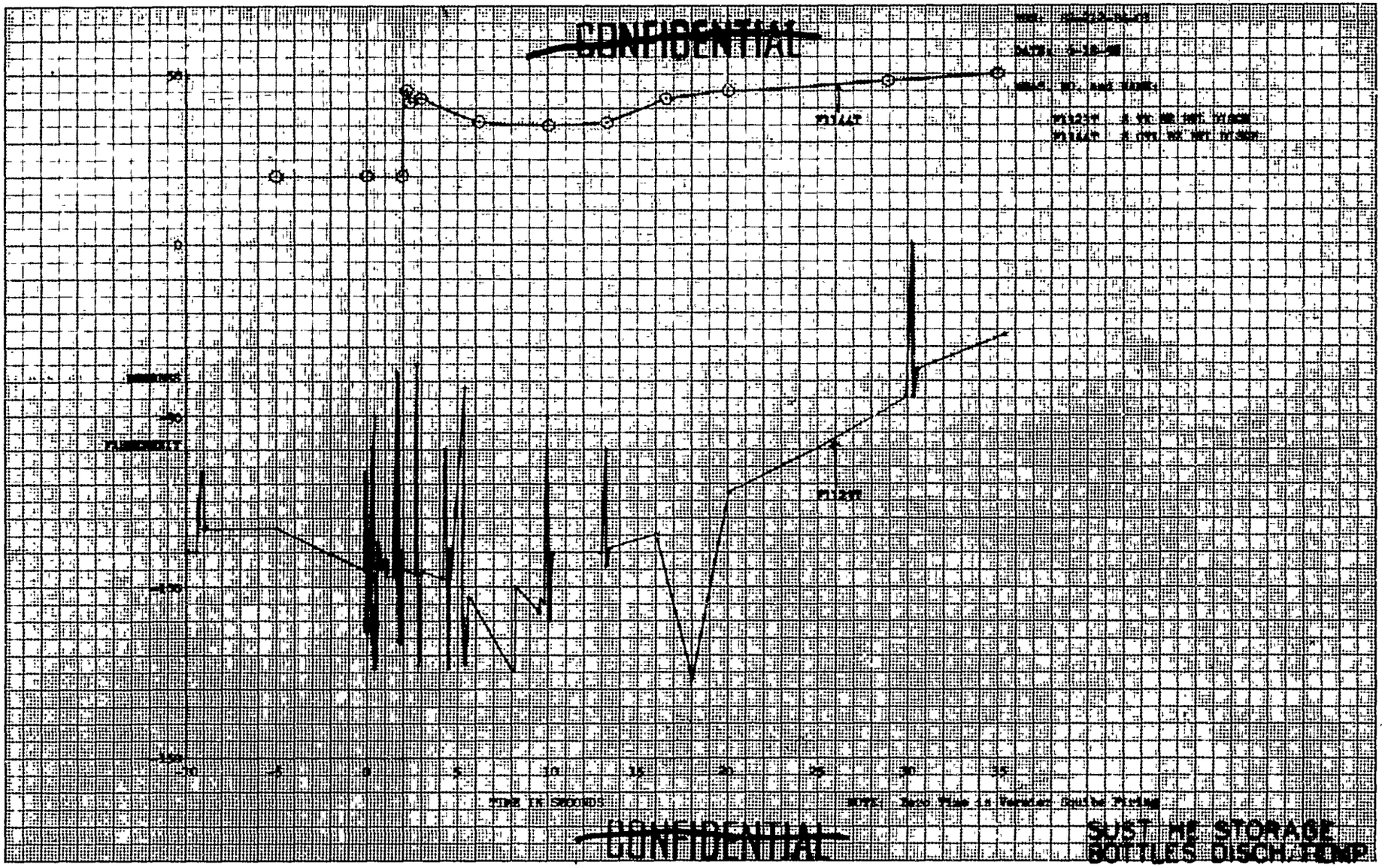
CONVAIR ASTRONAUTICS



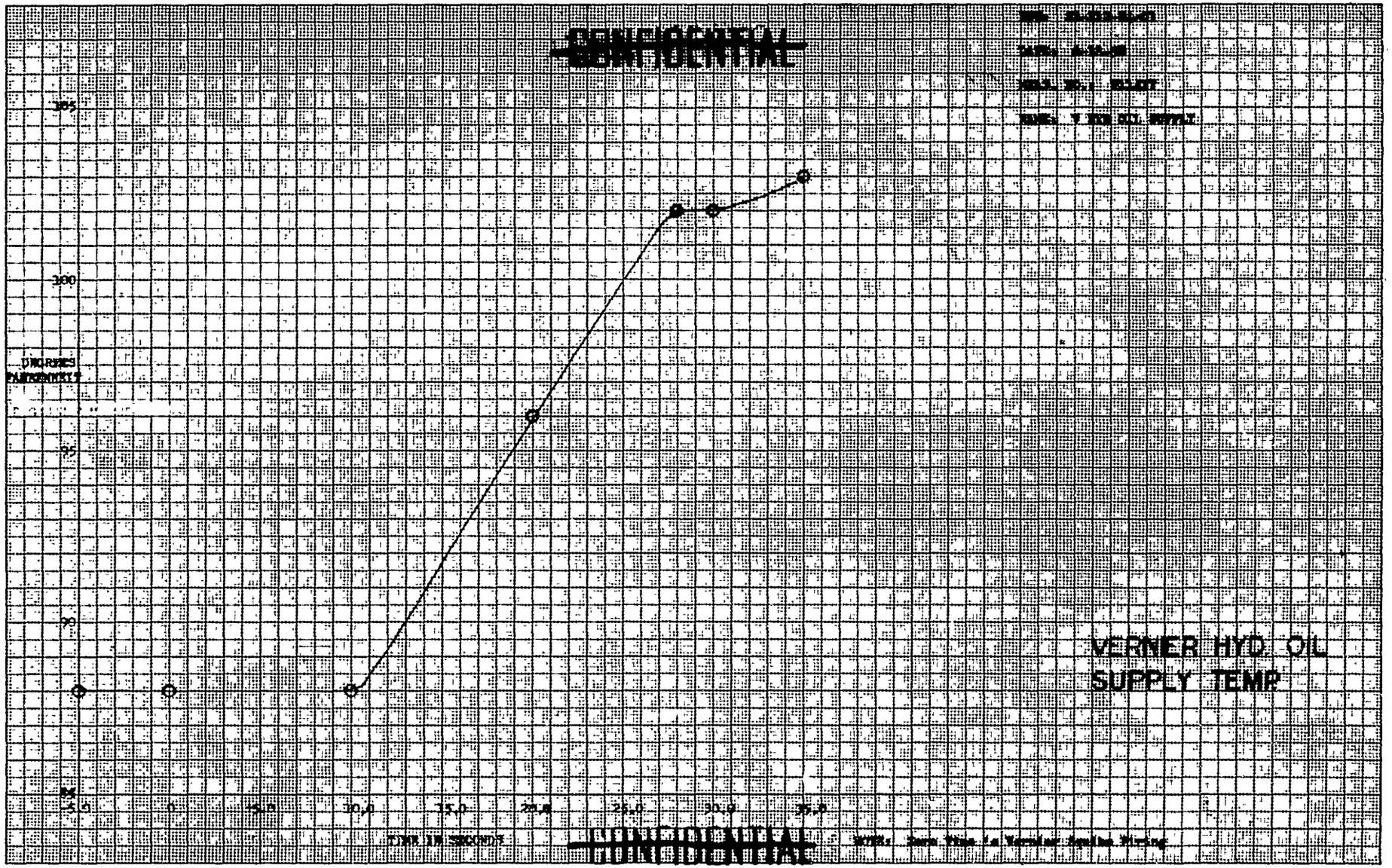
GRAPH No. 13


CONFIDENTIAL
160
140
120
100
80
60
DEGREES FAHRENHEIT
NOTE: Change in Function Scale at this point
200
240
280
320
-100
-50
0
100
200
300
400
500
600
CONFIDENTIAL
THRUST SECTION & VIBROTRON TEMP MEAS

GRAPH No. 14

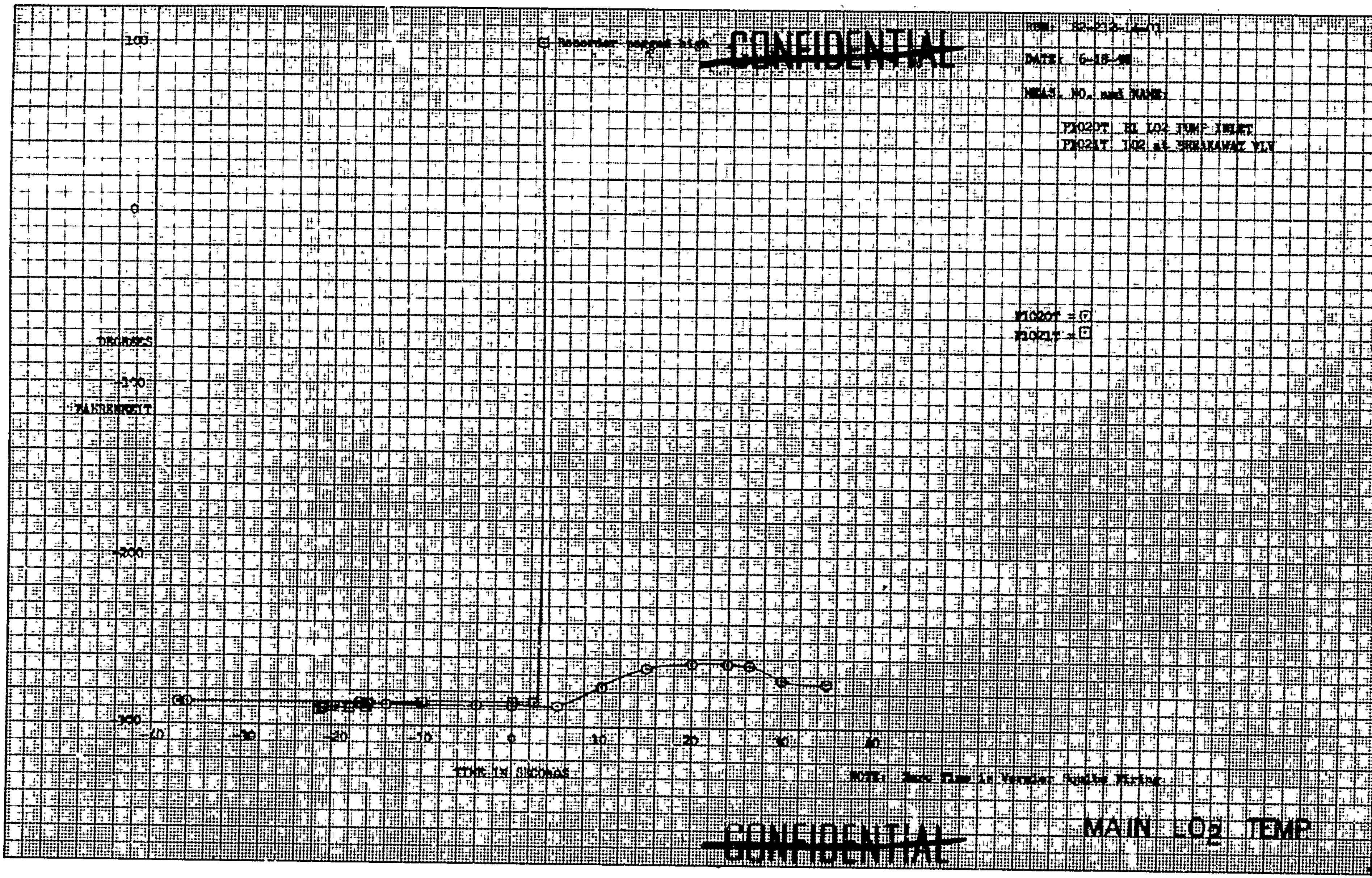

CONFIDENTIAL
50
0
-50
-100
-150
FAHRENHEIT
-10
-5
0
5
10
15
20
25
30
35
TIME IN SECONDS
P1144T
P1123T
P1143T
CONFIDENTIAL
SUST MF STORAGE
BOTTLES DISCH TEMP

GRAPH No. 15

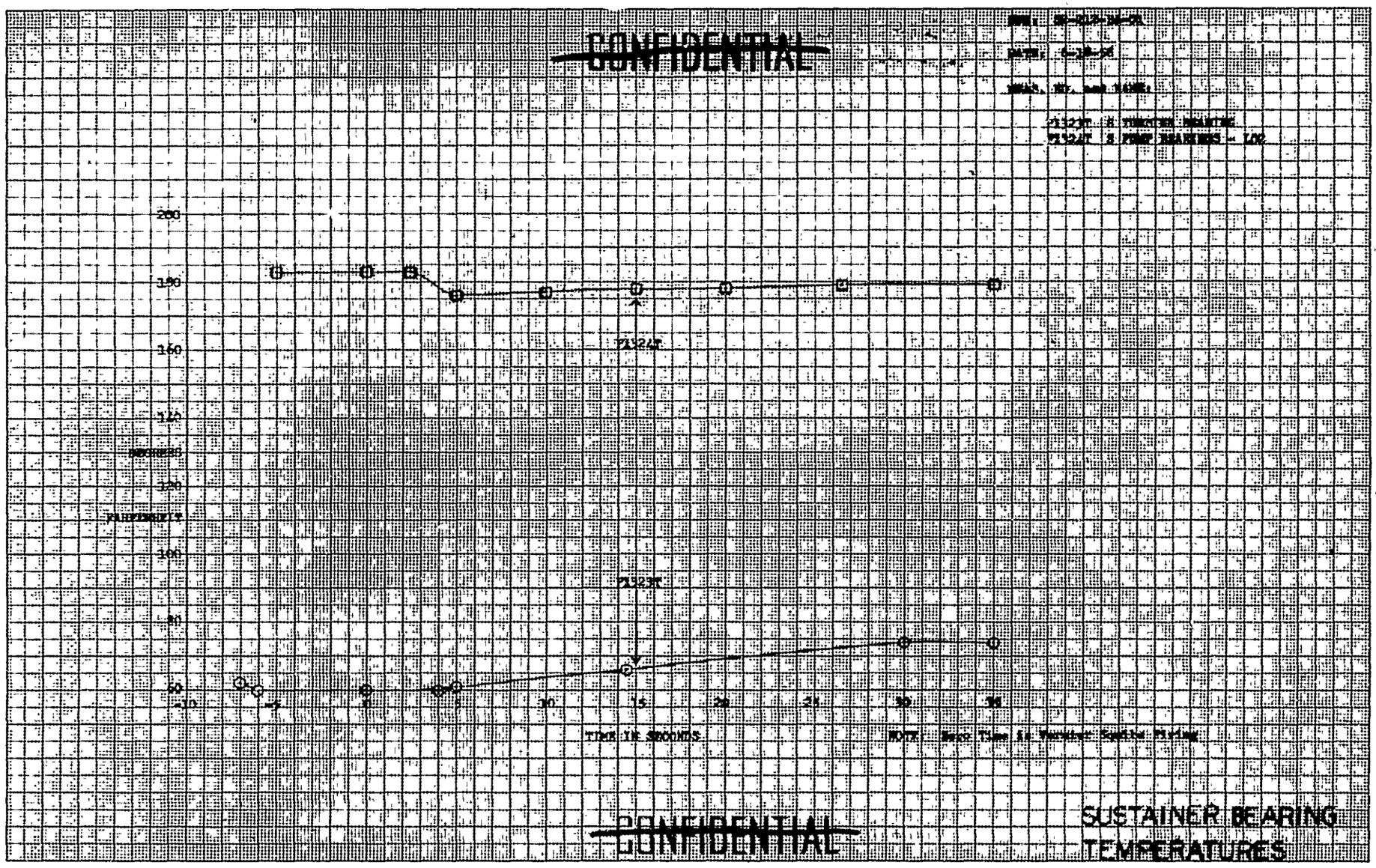


GRAPH No. 16

CONVAIR ASTRONAUTICS



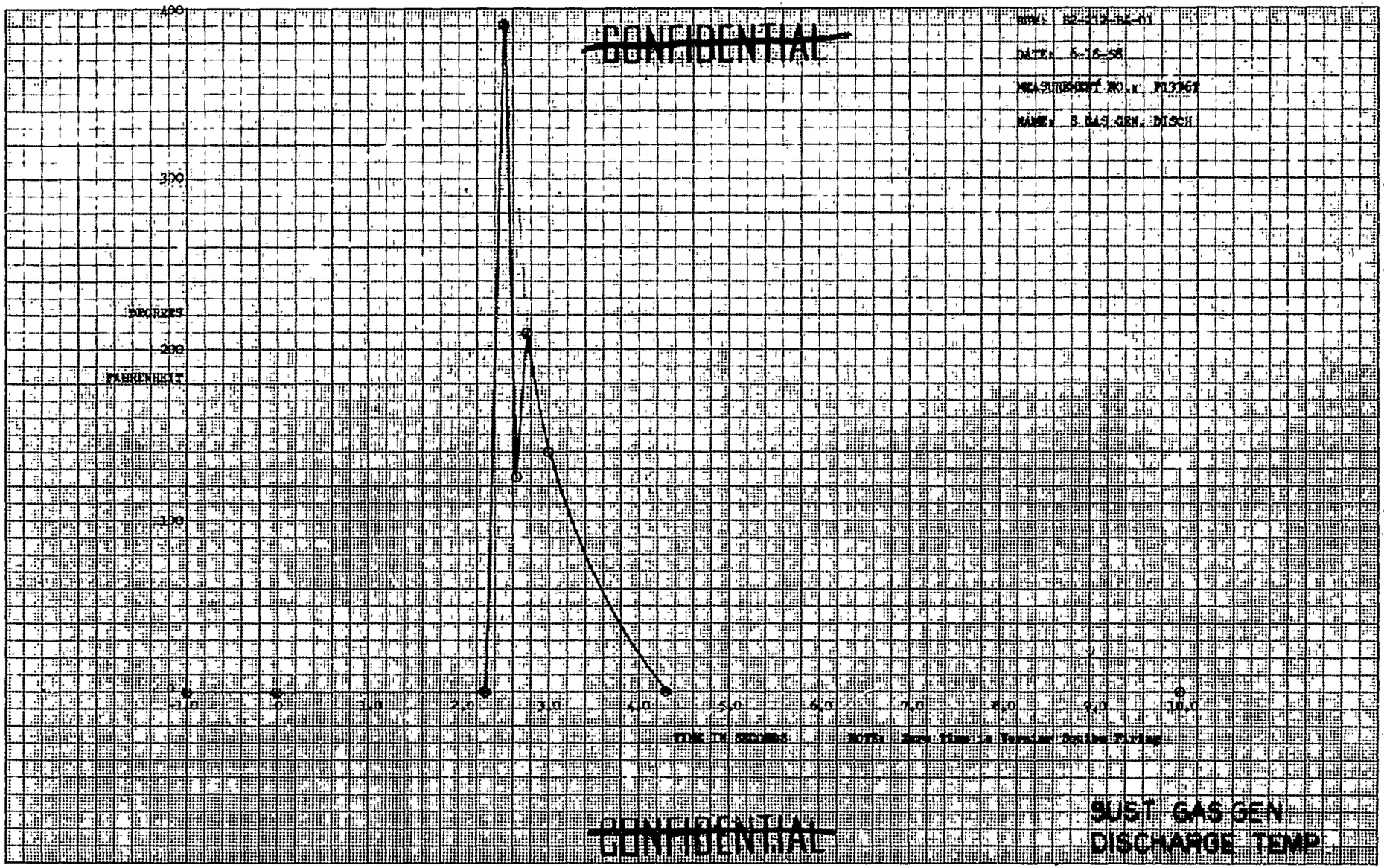
GRAPH No. 17



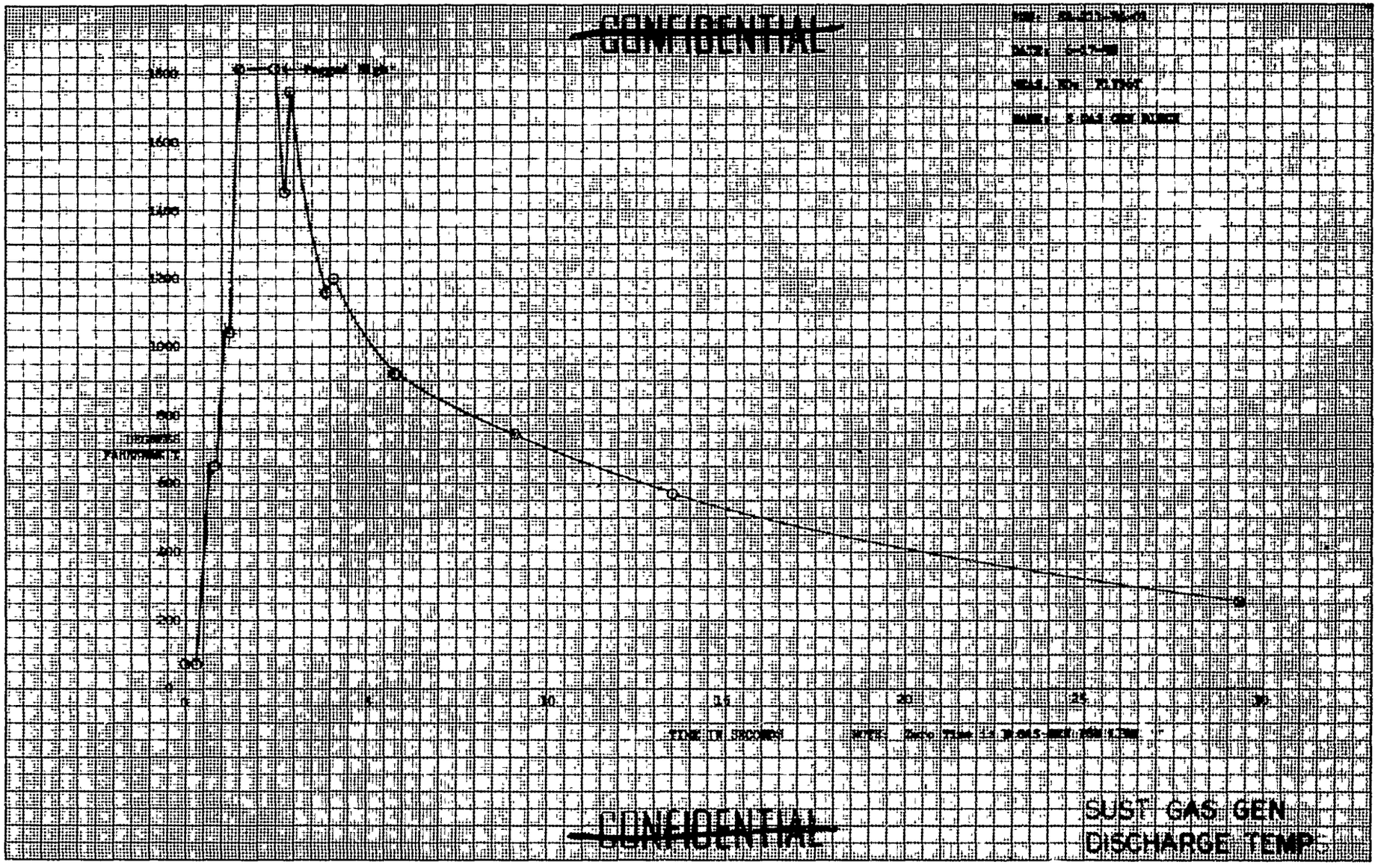
SUSTAINER BEARING TEMPERATURES

GRAPH No. 18

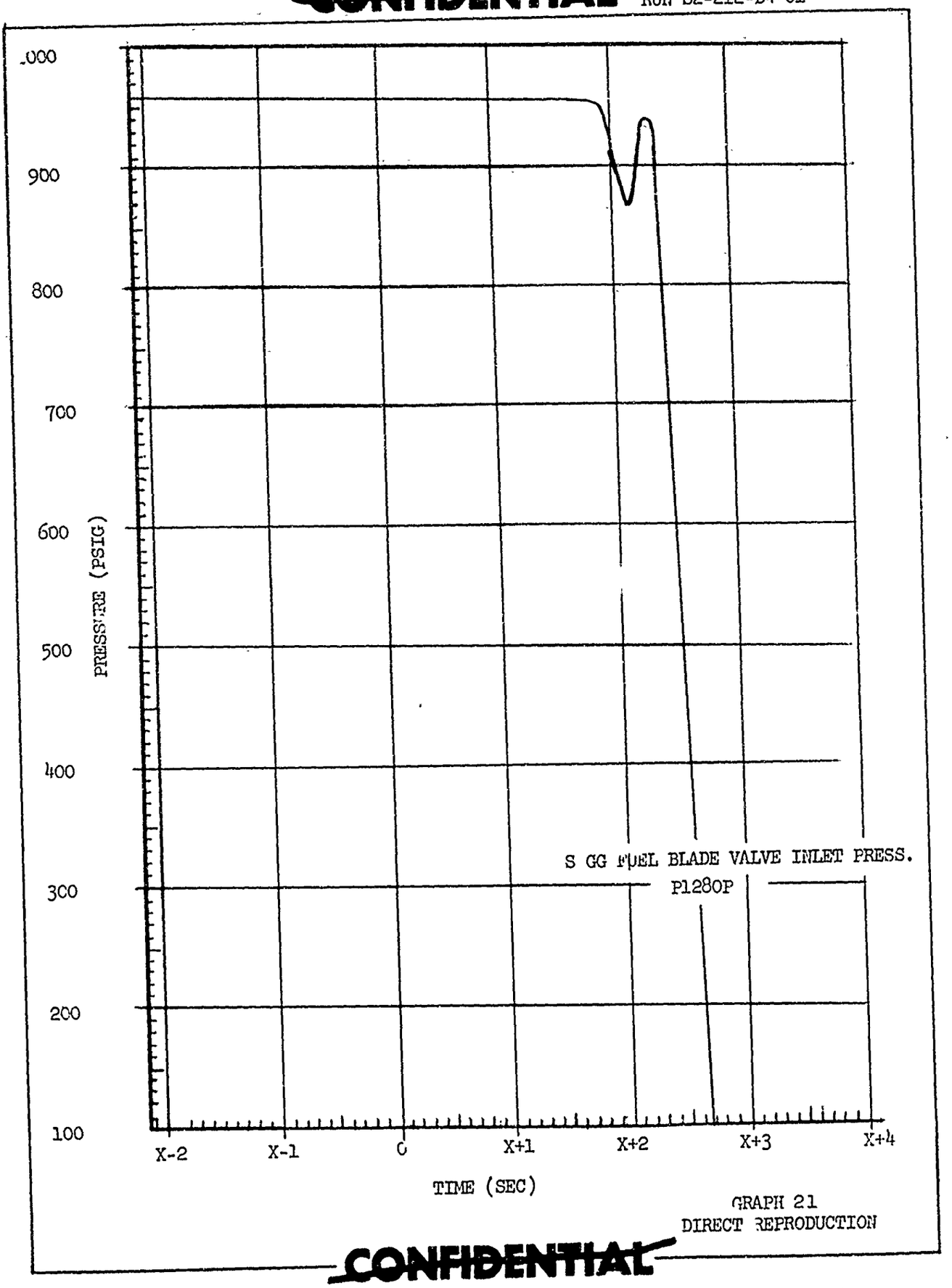
CONVAIR ASTRONAUTICS



GRAPH No. 19


CONFIDENTIAL
1800
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
TIME IN SECONDS
CONFIDENTIAL
SUST GAS GEN
DISCHARGE TEMP.

GRAPH No. 20



GRAPH 21
DIRECT REPRODUCTION

6.0 HARDWARE DAMAGE

6.1 The following is a summary of the hardware damage sustained by Missile 1B as a result of the explosion in the Sustainer turbine system.

6.2 Sustainer Engine

1) Nozzle and second stage turbine wheel blown off (See Photo 6).

2) Fuel pump volute cracked completely around circumference. Also crack approximately 10 inches long and 3/8 inches wide near hub. (See Photo 5).

3) Turbo pump gear case separated. (See Photos 5 and 28).

4) Gas Generator exhaust shroud torn off and blown upward toward Quads I and II (See Photos 1 and 7).

5) Exhaust shroud straps torn off and hanging loose. (See Photo 1).

6) Thrust chamber torn and twisted, tubes sheared from throat section downward. Primary force was applied from Quad IV to Quad II with heaviest damage at fourth band down from throat. Chamber bands were "U" shaped and exterior of Quad IV was compressed to interior of Quad II. (See Photos 1 and 2).

7) Three cannon connectors were broken on Engine Relay box. Bottom of Relay box slightly bent around connector.

8) All drain lines were bent, twisted, and collapsed (See Photo 2).

9) Exhaust manifold blown out through flame bucket. One small section imbedded in skirt section at Quad IV. (See Photo 6).

10) Sustainer Gas Generator Number P086 (NAA 9512-44185-51) was removed and analyzed to determine the condition of the blade valves and combustion chamber. Results of the investigation disclosed the LO_2 downstream port seal was shattered and the upstream seal was cracked. (See Photos 17 through 28).

6.3 Booster Engine

6.3.1 B1 Thrust Chamber - Damaged beyond repair (See Photos 8 and 9).

1) Quad II damage consisted of an 8 inch cut 2 feet from the bottom, and a 1/4 inch hole 1 foot from the bottom of the thrust chamber.

2) Between Quads II and III damage consisted of a large 6 inch concave area with a 2 inch hole through the wall 3 feet from the bottom, eight smaller holes and concave areas, and a 1/2 inch hole through the wall.

6.3.1 (Cont'd)

3) Damage in Quad III consisted of two 2 inch holes approximately 2 feet from bottom of chamber, a 2 inch cut and a small hole through the wall 3 feet from the bottom, a 1/2 inch hole and twelve collapsed tubes 1 foot from the bottom, a 1/2 inch hole 7 inches from the bottom, and three small dents 3 inches from the bottom.

6.3.2 B2 Thrust chamber - Heavily damaged (See Photos 10 and 11).

1) Damage consisted of punctured tubes and 1/2 inch holes between second and third bands of chamber, a 6 by 14 inch concave area and collapsed tubes between third and fourth bands on side toward Sustainer. The area was dented diagonally for 3 inches. In addition, eight tubes were sheared off.

6.3.3 Booster Engine Components

1) Miscellaneous engine plumbing destroyed (See Photo 2).

2) Booster turbine exhaust duct below heat exchanger collapsed. (See Photos 3 and 7).

3) Lube oil tank punctured. (See Photo 4).

4) Pneumatic control system damaged extensively.

5) An estimated 90% of all engine control wiring destroyed.

6.4 Vernier Engine No. 1

6.4.1 Damage to the V-1 engine consisted of the following:

1) Pressure switch harness burned.

2) Pitch actuator harness burned.

3) Several wires in Plug P90208-7 were charred and potting compound around plug was melted.

4) Ground wire to Receptacle J90208-7, and several other wires were charred.

6.5 Thrust Section (See Photo 14)

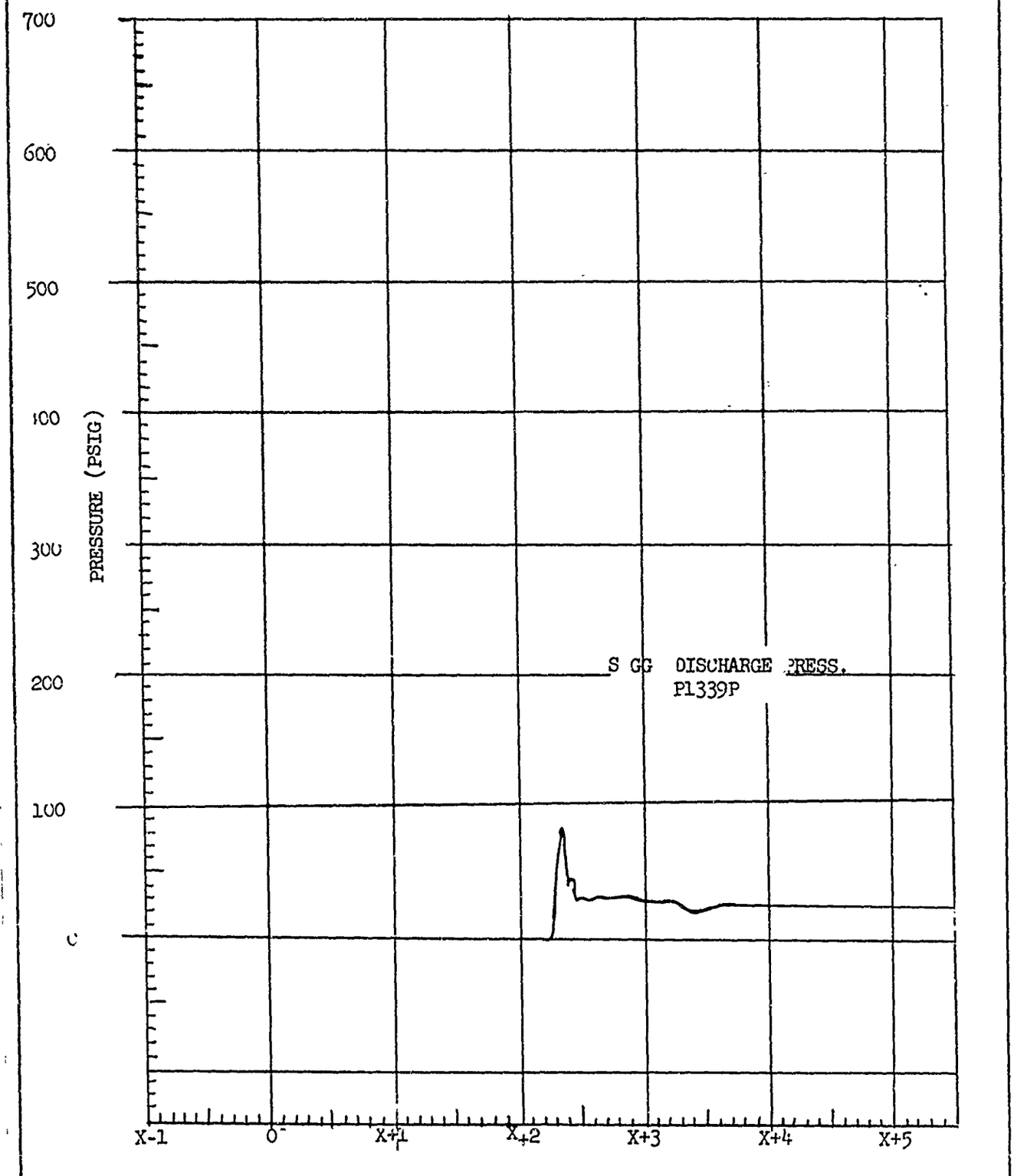
6.5.1 Damage in Quad I

1) Interskin and compression strut pulled loose at Sta 1248.

2) Interskin pulled loose 75 inches from Quad I between Sta 1248 and 1297.

3) Skirt section pulled loose from rivets in barrel section between Sta 1297 and Sta 1248.

~~CONFIDENTIAL~~



GRAPH 22
DIRECT REPRODUCTION

~~CONFIDENTIAL~~

6.5.1 (Cont'd)

4) Horizontal strut and bulkhead at Sta 1268 pulled from rivets. Bulkhead rippled.

5) Strut between Sta 1297 and Sta 1268 pulled loose with some corrugation.

6) Bulkhead web at Sta 1248 pulled loose from rivets and bulkhead rippled.

7) Bulkhead web at Sta 1297 pulled loose at rivets.

6.5.2 Damage from Quad I to Quad II

1) Split along rivets in thrust barrel section at Sta 1268.

2) Dents (35) ranging from 9 to 15 inches from end of barrel between each corrugation.

3) Interskin pulled loose from rivets at Sta 1297 bulkhead.

4) Interskin pulled loose from rivets at Sta 1268.

5) Interskin on X-X axis pulled loose from Sta 1248 to Sta 1297.

6) Interskin pulled loose from rivets at Sta 1297 bulkhead.

7) LN_2 fill and drain line damaged by 2 inch hole at Sta 1248.

6.5.3 Damage in Quad II

1) Tubing badly burned.

2) Interskin pulled loose 15 inches from Quad II between Sta 1206 and Sta 1297.

3) Corrugation pulled loose from Sta 1297 bulkhead.

6.5.4 Damage from Quad III to Quad IV

1) Bulkhead web at Sta 1299 torn loose from rivets. Eight feet of Web torn in many places.

2) Innerskin riveted to corrugation from Sta 1268 to Sta 1299 torn loose. Multiple cracks in innerskin and rivets pulled out.

3) Innerskin riveted to corrugation from Sta 1268 torn loose. Rivets pulled out and stiffeners cracked.

4) Corrugation of Sta 1248, halfway between Quads, torn loose from rivets.

6.5.4 (Cont'd)

5) Launcher purge and control panel between Quads at Sta 1300 demated and twisted. (See Photo 13).

6.5.5 Damage in Quad IV (See Photos 12, 15 and 16)

1) Compression struts torn loose from mounting brackets at Sta 1245 and Sta 1280.

2) Large diagonal hole, 12 by 4 inches, torn in corrugation of Booster pod extension at Sta 1287.

3) Diagonal hole in 6 inch section of bulkhead at Sta. 1299.

4) Disconnect panel (7-77260-1) at Sta 1268 disconnected and twisted.

5) Corrugation at Sta 1299 torn loose by piece of Sustainer exhaust shroud. Corrugation extended about 12 inches.

6) Bulkhead rivets at Sta 1299 pulled out. Web and angle web torn.

7) Rivets pulled loose from corrugation at Sta. 1268. Corrugation and webbing torn across width and corrugation extended about 12 inches.

8) Stiffener at Sta 1240 pulled out and a crack, about 10 inches, extends away from rivets.

9) Innerskin riveted on corrugation, behind jettison rail from Sta 1206 to 1248, torn and pulled from rivets.

10) Corrugation of Sta 1268 pulled from former bulkhead and extended from 1 to 12 inches away from center of thrust chamber.

11) Vertical tear in inner skin along rivets between Sta 1230 and 1240 extends about 30 inches from X-X axis.

12) Vertical tear in inner skin along rivets between Sta 1240 and Sta 1247 extends for about 15 inches from Y-Y axis.

13) Thrust barrel parted from bulkhead at Sta 1268 for about 4 feet starting at X-X axis.

14) Hole torn in thrust barrel structure on X-X axis.

15) Hole torn in thrust barrel structure about 12 inches from X-X axis.

6.6 Thrust Section Interior

6.6.1 General Damage

1) Heat exchanger dented for about 1/4 its circumference on side facing the Sustainer.

6.6.1 (Cont'd)

2) Lower compression strut mounting bracket broken and piece missing.

3) Gusset (7-77961-38) bent and torn with one rivet popped out.

4) Angle strut (7-77961-34) bent and torn.

5) Entire area below bulkhead at Sta 1268 heat blistered.

6) CO_2 and Firex pipe bent and twisted in Quads I and IV. Firex pipe smashed into B1, causing severe damage. (See Photo 9) Braces for Firex pipe bent and twisted.

7) Compression struts in Quads I and IV torn loose from thrust section skirt (both upper and lower strut). In Quad II, only the upper strut is loose. In Quad III, only the lower strut is loose.

8) LN_2 supply line to pressurization bottle shroud caved-in directly below shroud in Quad I and II.

9) B1 engine relay box connectors burned and broken.

10) Split 3 inches long in bottom half of Booster lube oil tank on Quad IV side. (See Photo 4)

11) Lower Booster relay box bracket torn off.

12) Oval shaped crack about 12 by 8 inches in diameter in Sustainer turbopump gear case.

13) Crack in fuel volute of Sustainer turbopump. (See Photo 5).

14) Engine pneumatic manifold wiring charred and burned.

15) Booster exhaust duct caved-in below heat exchanger. Small dent in heat exchanger. (See Photo 7).

16) On lower Booster engine relay box, one cannon connector broken and 2 connectors burned and cracked. Cannon connector lines burned and cracked.

17) Asbestos on thrust section heating duct torn, twisted, and burned.

6.7 Missile Pods

6.7.1 Damage to equipment in Missile pods was as follows:

1) Ground wire for MSD plug and J1131 connector burned entire length (approx. 24 inches).

2) Taped end of ground cable at base of pod burned approximately 3 inches.

6.7.1 (Cont'd)

3) Potting compound for MSD cable and connector (J1131) charred 6 inches from connector.

4) Pod doors paint blistered in area 6 inches wide over entire length of doors.

6.8 Facilities

6.8.1 Damage to facility equipment was as follows:

1) Rubber insulation from wire between Quads I and IV burned and melted along trunnion at level 17.

2) Rubber insulation on wire at level 17 between Quads III and IV melted and burned.

3) Leak in hydraulic flex line at rise-off fitting in Quad IV, level 17. (See Photo 13).

4) All rise-off panel hydraulic flex lines between Quads III and IV at level 17 are badly discolored from smoke and burning.

5) Flex heater duct across deck between Quads I and IV at level 17 burned for about 6 feet of its length.

6) Foil wrapping on Pod coolant flex line in Quad IV, level 17, blown and tattered. Little evidence of flex line burning.

6.9 Tower

6.9.1 Damage to tower components and equipment was as follows:

1) Curtain on south east side of tower at level 17 badly burned.

2) Pod cooling duct between levels 17 and 27 scorched and burned for about 6 to 7 feet. All of one "Y" duct scorched and burned.

3) Paint was badly scorched on southeast bottom side of tower level 35 platform.

4) Paint on south bottom sides of tower level 27 platforms badly scorched and damaged by water.

5) Thrust barrel heater ducting at level 17 badly scorched and burned in several places.

6) Fence, railing, and duckboards on level 17 badly corroded and damaged by fire and water.

7) CO_2 piping south side of level 17 badly corroded and damaged by fire and water.

6.10 Instrumentation

The following transducers were rejected by inspection as a result of damage sustained during the accident.

MEASUREMENT NO.	NAME	TRANSDUCER PART NO.	SERIAL NO.
A95P	FAIRING DIFFERENTIAL	7-01225-805	7
A109P	FAIRING DIFFERENTIAL	7-01225-805	204
F1011P	LO_2 PRESS REG DISCH	7-01225-803	57
F1114P	LO_2 PRESS REG INLET	7-01226-801	148
F1124P	S TANK HE BTL DISCH	7-01226-801	267
H1033P	B1 HYD ACCUMULATOR	7-01226-801	246
H1052P	S HYD ACCUMULATOR	7-01226-5	13
H 1T	MSL HYD PUMP DISCH	7-01223-5	67
P1349B	S PUMP SPEED	7-01437-A1	NAA
P 2P	B1 FUEL PUMP INLET	7-01226-1	15
P1010P	B1 LUB OIL MAN	7-01226-3	136
P1027P	VERNIER FUEL TANK	7-01226-3	442
P1059P	B2 THRUST CHAMBER	7-01627-5	2297
P1091P	B1 LO_2 INJ MAN	7-01627-801	2027
P1093P	B1 FUEL INJ MAN	7-01627-801	3534
P1094P	B2 FUEL INJ MAN	7-01627-801	1763
P1235P	VERN LO_2 TK REG OUT	7-01226-3	46
P1280P	S GG FUEL VLV INLET	7-01226-3	65
P1330P	S FUEL PUMP DISCH	7-01226-801	50
P1332P	S LO_2 PUMP DISCH	7-01226-801	5
P1489P	B GAS GEN LO_2 VLV IN	7-01226-3	3
P1014T	ENG COMP AMBIENT	7-01223-1	52
P1017T	B2 TURBINE IN	7-01265-801	17
ST171P	BGG FUL ORFC BLK IN P	7-01226-3	41

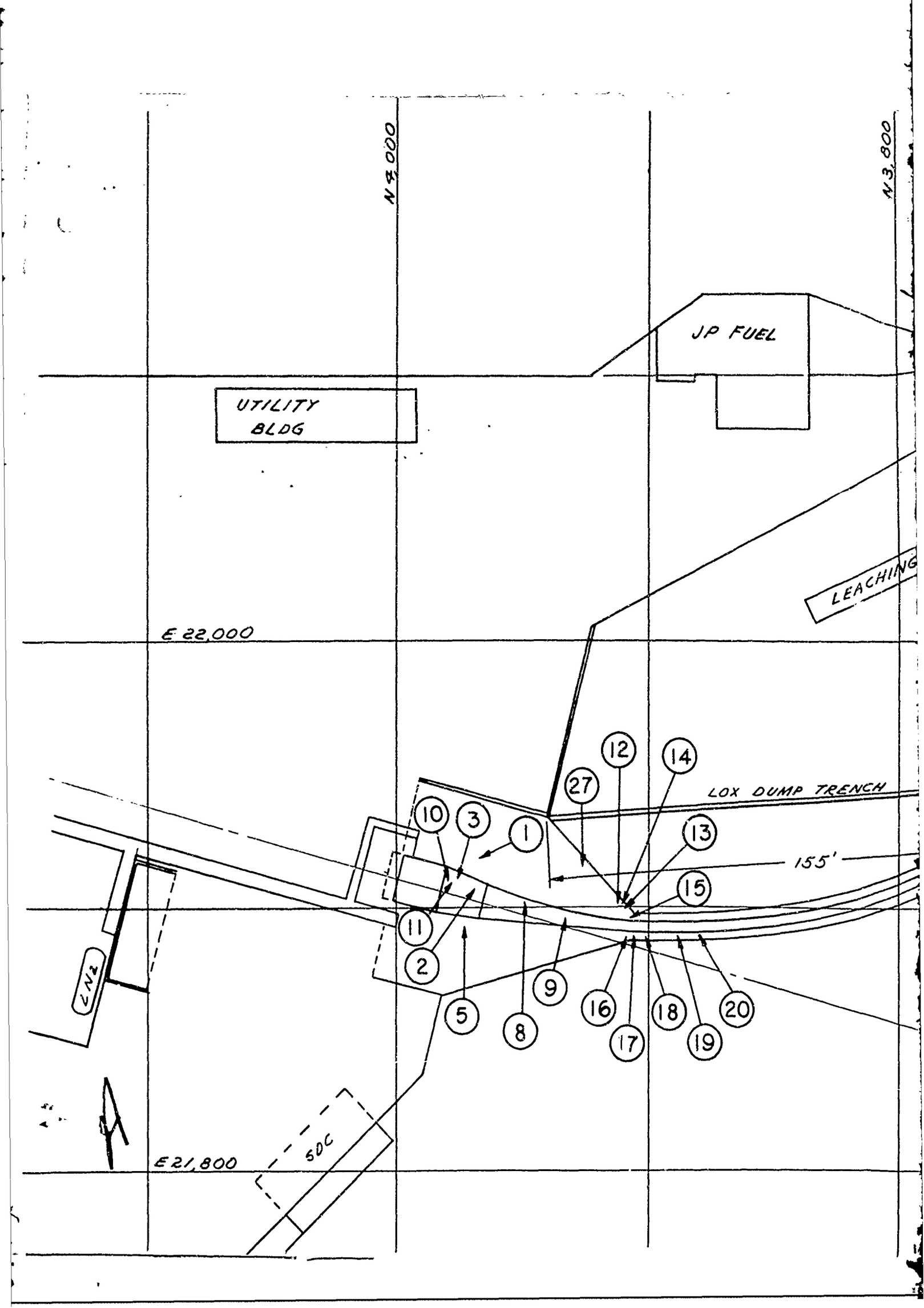
6.11 FRAGMENTATION SURVEY

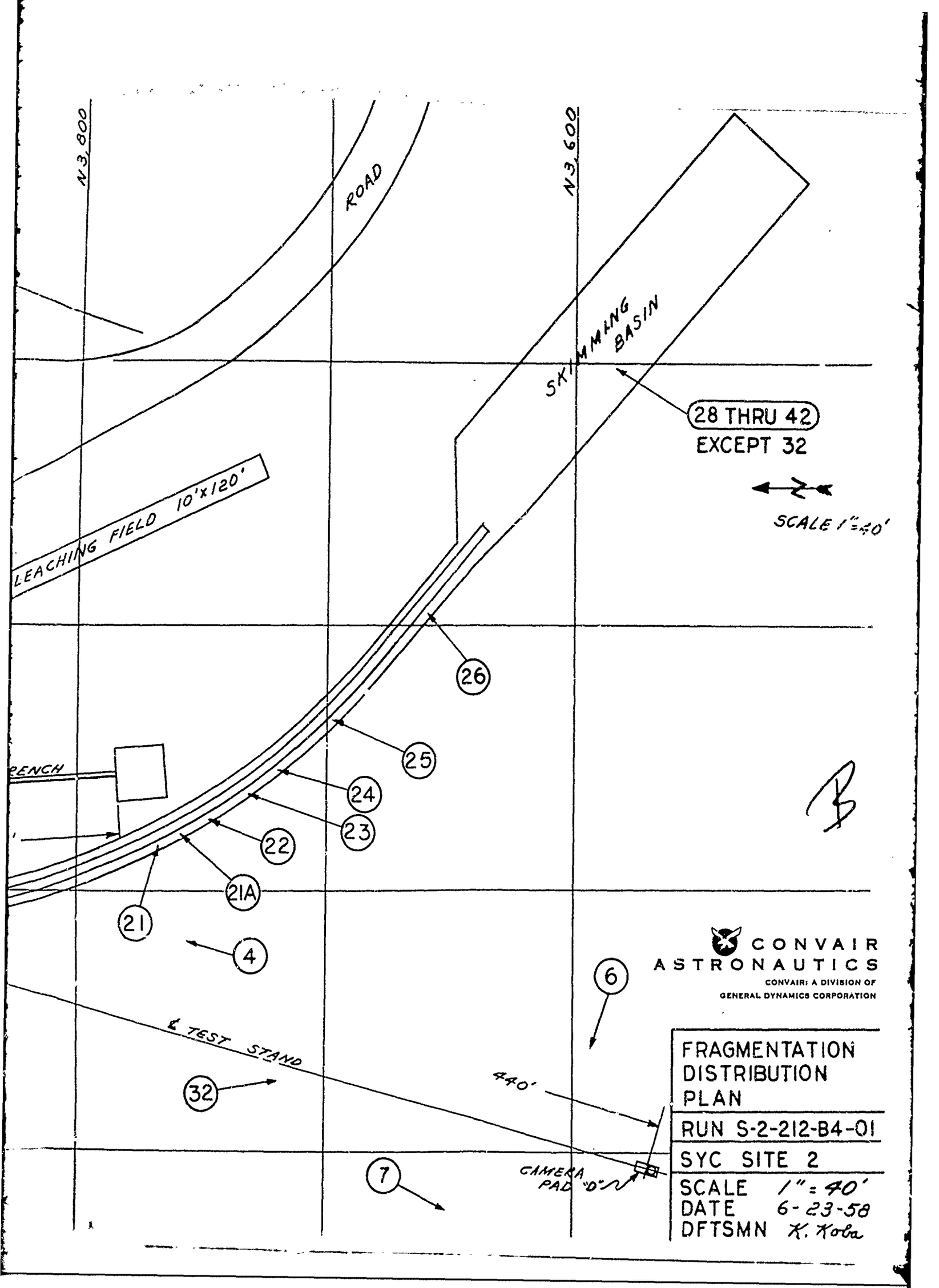
6.11.1 As part of the activities of the hardware investigation committee a survey was conducted to locate and identify all fragments of the missile blown from the stand area during the explosion. The locations of all fragments discovered was recorded on a map of the area (reproduced on the following page) and each fragment was inspected and identified by Convair and Rocketdyne personnel.

6.11.2 The locations of the individual fragments is not considered significant. The majority of the fragments were recovered from the flame deflector wash and the fuel skimming pond after it was drained. The majority of the fragments were found where they were carried by flame deflector water.

6.11.3 Exceptions to this are fragments number 4, 6, 7 and 32 which were located where they fell.

6.11.4 A list identifying individual fragments shown on the distribution plan is reproduced on page 19.


N 4,000
N 3,800
JP FUEL
UTILITY BLDG
LEACHING
E 22,000
LOX DUMP TRENCH
155'
LN2
SDC
E 21,800
1
2
3
5
8
9
10
11
12
13
14
15
16
17
18
19
20
27


N3,600
ROAD
N3,600
SKIMMING BASIN
28 THRU 42
EXCEPT 32
SCALE 1"=40'
LEACHING FIELD 10'x120'
26
25
24
23
22
21A
21
4
6
7
32
440'
CAMERA PAD "D"
CONVAIR
ASTRONAUTICS
CONVAIR: A DIVISION OF
GENERAL DYNAMICS CORPORATION
FRAGMENTATION
DISTRIBUTION
PLAN
RUN S-2-212-B4-01
SYC SITE 2
SCALE 1" = 40'
DATE 6-23-58
DFTSMN K. Koba

6.12 Individual Fragment Identification List

1) Instrumentation pickup.

2) 3 small steel fragments, heavily carboned on one side.

3) Fragment - marked 4-1102-75.

4) Second Stage Sustainer Turbine wheel

5) S cap fitting, marked with orange paint. Does not appear to have come from the explosion.

6) Aluminum fragment.

7) Strap for retaining boot.

8) Two inch piece of drain line

9) 3-4 inch fragment, probably from the Sustainer GG exhaust duct manifold.

9A) Similar to number 9. Located one foot to the south..

10) Cable assembly with a brass identification band stamped J-3067-2.

11) Two identification tags and a two inch piece of line marked as follows:

TAG NUMBER ONE: 4600 PSIG
TVA 71230-13
TAG NUMBER TWO: Set at 4600 psig
89-34906-002-13
TWO INCH PIECE: 7-17706-13 CVA 325 - 01

12) Part of an Igniter cable

13) Another igniter cable.

14) A piece of cable with color coded wiring. Does not appear to have come from the explosion.

15) A group of parts found together including:

a) An igniter cable and a Vernier Igniter clamp marked 9512412-07
b) Six fittings for attaching the boots. These parts appear to have been brought together by flame deflector water action.

16) Two small metal fragments

17) One of the bolts which attaches the second stage turbine wheel to the turbine shaft.

18) Fragment

6.12 (Cont'd)

19) Turbine wheel blade.

20) 2-3 inch fragment

21) 2-3 inch fragment

21A) Large twisted fragment. 20, 21 & 21A all appear to have come from the Sustainer GG exhaust system.

22) Two pieces of tubing, a fitting holding them together, and a small (separate) piece of aluminum. The tubing appears to be part of the Sustainer drain lines.

23) A piece of Sustainer "Broomstick" igniter which does not seem to have been exposed to weather and is probably from Run S2-212-B4-01.

24) A fragment and an identification tag marked 7-67742-801 CVA 148 -01

25) A one inch piece of tubing.

26) A piece of aluminum probably from one of the fittings used to attach the boots.

27) A turbine wheel blade.

All parts numbered 28 through 42 were found in the Skimming Pond with the exception of number 32.

28) A large piece of the Sustainer GG exhaust.

29) A large thicker fragment. Appears to be from the Sustainer GG exhaust manifold.

30) Two pieces of Sustainer Thrust Chamber re-inforcing bands.

31) Piece of tubing. Probably from one of the Sustainer drain lines.

32) Aluminum tag stamped number one.

33) Sustainer Turbine Second Stage Inlet Nozzles.

34) Eighteen inch section of the Sustainer GG exhaust duct.

35) Part of the Sustainer GG exhaust duct manifold.

36) The Sustainer Pneumatic Helium Heat Exchanger coils.

37) Four pieces of U channel considerably deformed. Probably Sustainer thrust chamber reinforcing bands.

38) Three pieces of strap.

6-12 (Cont'd)

39) LN_2 shroud duct marked 7-87570-BN-01.

40) Two pieces of the Sustainer thrust chamber wall tubing.

41) A group of fragments from the Sustainer GG exhaust duct and exhaust duct manifold.

42) A piece of the fiberglass firewall.

Miscellaneous - A collection of small fragments, fittings, etc., placed in a box marked "Misc. parts Run S2-212-B4-01."

7.0 CONCLUSIONS

The explosion was caused by damaged seals in the Sustainer Gas Generator LO_2 blade valve. These seals were damaged at cutoff during Run 211. LO_2 was flowing past the Sustainer Gas Generator blade valve from a time early in Lox tanking. LO_2 saturated the residual material in the Sustainer Gas Generator, Sustainer Turbine and the Gas Generator exhaust duct and manifold. The resulting hydrocarbon gels were detonated by the Sustainer Gas Generator igniters firing. The explosion was centered in the Sustainer turbine probably at a point between the first stage turbine wheel and the second stage nozzles. Secondary explosions may have occurred in the exhaust duct and manifold. The cause of the LO_2 blade valve seal failure has not been positively determined. It is suspected that the seals were damaged by a minor explosion which occurred between the Sustainer gas generator injection head and the LO_2 manifold at cutoff on Run 211. A second and less probable theory is that the seals became misaligned and were damaged by the LO_2 blade valve closing.

8.0 RECOMMENDATIONS AND CORRECTIVE ACTION

8.1 It is recommended that Gas Generator purge procedures be reviewed and implemented to ensure adequate purge pressure and duration. During the next test firing of missile 1B it is planned to modify purge procedures. GG purges will be turned on five seconds prior to Vernier engine start and continued for ten minutes after cutoff. Purge source pressure will be increased to ensure adequate purge pressure.

8.2 Gas Generator propellant flows and temperature measurements should be checked during propellant tanking and after firing to aid in detecting leaks.

8.3 The S2 water and CO_2 fire fighting systems were demonstrated to be adequate in controlling a fire of this nature. It is recommended that these systems be mandatory for all static firings

8.4 Closing of pre-valves as a part of emergency fire procedures should be adopted as standard procedure for all static firings. Local controls for the Booster and Sustainer pre-valves should be provided.

APPENDIX A

FINAL COUNTDOWN
RUN S2-212-B4-01

14 JUL 83 PAGE 001

LOCATION OR PANEL

OPERATIONS CALLED FOR TEST CONDUCTOR — FEEDBACK

PREDICT TYPE ATP

CHECK CO... IGNITION SEQUENCE CIRCUIT GROUP

...ACCEPT-REJECT CRITERIA IS X-1/2 HOURS

...E IGNITION

...OVER REPORT ...

TIME / REPORT ...

TURN ON THE FOLLOWING ... SEQUENCE SWITCHES

1- FLAME DEFLECTOR — FLAME DEFL

4- FUEL TANKING — FUEL TNKNG

/-PU POWER ON ...

-OPEN FUEL PRE-VALVE — LG

3- LO2 CONTROL — LO2 CNTRL

4-CLOSE PUMP INLET VALVE — J

4- FIREX — FIREX

5- ENGINE CONTROL ... — ENG CNTRL

...SET UP ISOLATED ELECTRICAL POWER SYSTEM

1- SET TIC FOR ... SELECTOR ... — PRESTART

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

		STATIC FIRING		
		2- AC METER SELECTOR SW TO EXT		MSSL POWER
		3- AC POWER SOURCE SW TO EXT	A	MSSL POWER
		4- DC POWER SOURCE SW TO EXT	A	MSSL POWR
		5- MISSILE DC POWER SW ON	G	MSSL POWER
		A-ADJUST TO 28 VDC		
		6- MISSILE AC GENERATOR SW ON	G	FACLTY PWR
		7- AFTER 2 MIN, MISSILE AC POWER SW ON	G	MSSL POWER
		A-ADJUST TO 115 VAC @ 400 CYCLES		
[illegible]	[illegible]	* START MISSILE POD COOLING SYSTEM & REPORT		
		1- START POD COOLER		COOLER PAD
		2- SUPPLY OPER. CONDENSER PUMP THROTTLE VALVE 1PC		COOLER PAD
		3- [illegible] AT 45F	45F	COOLER PAD
[illegible]	[illegible]	[illegible] AUTOPILOT SYSTEM & REPORT		
		1- AUTOPILOT [illegible]	A	AUTOPILOT
		2- AUTOPILOT DC POWER SW ON	A	AUTOPILOT
		A-CHECK [illegible] LITES ON	2A	
		3- [illegible] AUTOPILOT [illegible] HEATER		AUTOPILOT
		LIGHTS OFF, CHECK [illegible] CYCLES	G	AUTOPILOT
		LIGHT ON IN 15 MIN		
		4- AUTOPILOT [illegible]	A	AUTOPILOT
		5- CHECK FIL [illegible] LITES OPERATING	3A	AUTOPILOT
		6- CHECK [illegible]	A	AUTOPILOT

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

7- CHECK ERR CUTOFF ADJUST CKT OFF		A/P PG BAS
8- CHECK TRANSDUCER EXCITATION UNIT		TEU RACK
PANEL POWER LITE ON		
9- TRANSDUCER EXCITATION UNIT POWER		TEU RACK
SUPPLY SW ON		
-CHECK OUTPUT VOLTAGES AT LOAD		TEU RACK
1-6.3 VAC	6.3 VAC	
2-300 VDC	300 VDC	
[illegible] ACTIVATE A/P TEST PROGRAM AND RESET		
1- DEPRESS INDICATOR LIGHT TEST SW		A/P TST PG
CHECK ALL PANEL LTS		
2- PANEL POWER ON	2A	A/P TST PG
3- CHECK TEST PROGRAM AUX PANEL LITES		PG AUX PN
4- A/P TEST PROG PANEL PWR		A/P TEST
SUPPLY SW ON		PROGM BASE
A-CHECK VOLTAGES		
1-6.3 VAC	6.3 VAC	
2-150 VDC	150 VDC	
3-300 VDC	300 VDC	
4-450 VDC	450 VDC	
5- CHECK CHANNEL SENSOR UNITS AT RANGE		INST
A-REFERENCE VOLTAGE		
B-FULL POSITION		
C-SENSITIVITY		

~~CONFIDENTIAL~~

001?	SET SELECTORS IN OFF POSITION		
0011	ACTIVATE VIBROTRON MONITORING EQUIP & REPORT		
	ACTIVATED X-1 DAY-		
	1- CHECK LAMBDA POWER SUPPLY TURNED ON		INST
	A-AC POWER SW ON	R	
	B-DC POWER SW ON	R	
	2- CHECK FREQ MULTIPLIER SELECTORS TO 8		INST
	3- TURN ON PRINTER		INST
	A-POWER SW ON	R	
	B-STANDBY/OPERATE SW TO STANDBY		
	4- TURN ON LO2 & FUEL EPUT METERS		INST
	5- TURN ON FUEL VIBRATRON READOUT PANEL		INST
	A-CHECK GATE TIME SELECTOR TO 0.5 SEC		
	4- START BOOSTER GROUND PUMP	G	HYDRAULIC
	C-POWER SW TO ON	R	
	D-TIME BASE SW ON		
	E-COUNT SW TO OFF		
	6- TURN ON LO2 VIBRATRON READOUT PANEL		INST
	A-CHECK GATE TIME SELECTOR TO 0.5 SEC		
	B-CHECK SENSITIVITY SET TO 3 VOLT		
	C-POWER SW TO ON		
	D-TIME BASE SW OFF		
	E-COUNT SW TO OFF		
0012	ACTIVATE CONV IN P.U. SYST. FOR RUN & REPORT		

CONFIDENTIAL

CONFIDENTIAL

		1- AMPLIFIER AF001		TRANSFR RM
		A-SET GAIN SW TO 200		
		2- OVERFILL AMPLIFIER AF002		TRANSFR RM
		A-POWER SW ON	W	
		3- 100 AMPLIFIER AF003		TRANSFR RM
		A-POWER SW ON	W	
		4- BOOSTER LO2 LIQUID-GAS DETECTOR AMPL		TRANSFR RM
		A-POWER SW ON	W	
		5- SUS LO2 LIQUID-GAS DETECTOR AMPL		TRANSFR RM
		A-POWER SW ON	W	
		6- LIQUID OXYGEN TANK LEVEL INDICATOR		BLKHS-CC
		A-CHECK SCALE SELECTOR SW TO 1X		
		B-POWER SW ON	S	
-/12-	013	TURN ON LO2/GO2 DETECTOR PANEL/ARY D101		INST
		1- POWER SW ON	R	
		A-CHECK FOLLOWING POWER LITES ON		
		1-V1 LO2 BLEED	A	
		2-V2 LO2 BLEED	A	
		3-BOOSTER LO2 TANK VENT	A	
-1/2 [illegible]	014	ACTIVATE RCC SYSTEM & REPORT		
		1- ACTIVATE RCC [illegible] POWER [illegible]		ELCTRNC RM
		15 [illegible]		
		A-TEST PANEL SIG INPUT SW TO [illegible]		TEST PNL
		B-RCC [illegible] POWER SW ON	W	RCC [illegible] PNL

CONFIDENTIAL

CONFIDENTIAL

C-RCC DEVICE POWER SW ON	W	RCC DEVICE
D-BINARY COUNTER TEST/RUN SW TO RUN		B1 COUNTER
E-BINARY COUNTER POWER SW ON	W	B1 COUNTER
F-STEPPING SW COUNTER POWER SW ON	W	RCC STEP
G-RCC TEST/RUN SW TO RUN		RCC DEVICE
H-RCC CONTROL SW TO INACTIVE		B1 COUNTER
2- ACTIVAGE RCC CHANNEL 33 POWER- ALLOW 15 MIN WARMUP		ELCTRNC RM
A-TEST PANEL SIG INPUT SW TO RUN		TEST PNL
B-RCC MAIN POWER SW ON	W	RCC MN PWR
C-RCC DEVICE POWER SW ON	W	RCC DEVICE
D-BINARY COUNTER TEST/RUN SW TO RUN		B1 COUNTER
E-BINARY COUNTER POWER SW ON	W	B1 COUNTER
F-STEPPING SW COUNTER POWER SW ON	W	RCC STEP
G-RCC TEST/RUN SW TO RUN		RCC DEVICE
H-RCC CONTROL TO INACTIVE		B1 COUNTER
3- ACTIVATE RCC CHANNEL 34 POWER- ALLOW 15 MIN WARMUP		ELCTRNC RM
A-TEST PANEL SIG INPUT SW TO RUN		TEST PNL
B-RCC MAIN POWER SW ON	W	RCC MN PWR
C-RCC DEVICE POWER SW ON	W	RCC DEVICE
D-BINARY COUNTER TEST/RUN SW TO RUN		B1 COUNTER
E-BINARY COUNTER POWER SW ON	W	B1 COUNTER
F-STEPPING SW COUNTER POWER SW ON	W	RCC STEP

			G-RCC TEST/RUN SW TO RUN		RCC DEVICE
			H-RCC CONTROL SW TO INACTIVE		81 COUNTER
			4- CATHODE FOLLOWER POWER SUPPLY SW ON		TRANS RM
			5- AUDIO WARNING CHANNEL 32 POWER SW ON		TRANS RM
			A-CHECK GAIN SW SET AT 50	50	
			6- AUDIO WARNING CHANNEL 33 POWER SW ON		TRANS RM
			A-CHECK GAIN SW SET AT 50	50	
			7- AUDIO WARNING CHANNEL 34 POWER SW ON		TRANS RM
			A-CHECK GAIN SW SET AT 50	50	
			8- CHECK SENSITIVITIES SET AT RUN VALUES/CHANNELS 32, 33 & 34		ELCTRNC RM
X-1/27M	0013	*	CALIBRATE INSTRUMENTATION & RECORD ANY VARIATION BETWEEN STEPS & PRIOR CALIBRATION		INST
			X-1 DAY-		
	0016	*	SET UP CAMERA CONTROLS & REPORT		INST
X-2/13M	0017	*	ACTIVATE EMERGENCY DIESEL GENERATOR & REPORT		
			17 MIN-		
			1- DEPRESS RESET BUTTON ON TRANSFER PANEL BK22-19		BLKHS BSMT
			2- START DIESEL GENERATOR		BLKHS REAR
			3- AFTER 5 MIN WARMUP/CLOSE BREAKER ON GENERATOR PANEL		BLKHS REAR
			4- CHECK VOLTAGE AT 480 VAC		BLKHS REAR
			5- CHECK FREQUENCY AT 60 CYCLES		BLKHS REAR

		6- SWITCH COMMUNICATIONS TO EMERGENCY POWER			GLKHS BSNT
X-2/21H	0018	* CHECK & ADJUST ENGINE REG SETTINGS TO RUN VALUES			
		13 MIN-			
		1- CHECK ENG CONTROL VLV ITEM 67 OPEN			PCU
		2- CHECK ENG CONTROL SW ON			PNEUMATIC
		3- BROWN RECORDERS ON SLOW/LOCALLY			INST CNTRL
		4- S ENGINE CONTROL REG 750 ±/- 15 PSIG		750 ±/-15	MISSILE
		F1125P BAY D111-1			INST
		5- BOOSTER LO2 REF REG 525 ±/- 10 PSIG		525 ±/-10	MISSILE
		P1026P BAY D111-2			INST
		ST142P BAY D108-1			INST
		6- LO2 START TANK REG 450 ±/- 20 PSIG		450 ±/-20	MISSILE
		P1177P BAY D113-3			INST
		7- SUS ENG CONTROL REG 750 ±/- 15 PSIG		750 ±/-15	MISSILE
		F1142P BAY D113-1			INST
		8- SUS LO2 REF REG 810 ±/- 10 PSIG		810 ±/-10	MISSILE
		P1344P BAY D113-2			INST
		9- VERNIER FUEL TANK REG 535 ±/- 10 PSI		535 ±/-10	MISSILE
		P1236P BAY D110-2			INST
		10-VERNIER LO2 TANK REG 520 ±/- 10 PSIG		520 ±/-10	MISSILE
		P1235P BAY D109-2			INST
		11-FUEL START TANK REG 800 ±/- 40 PSIG		800 ±/-40	MISSILE
		P1178P BAY D111-3			INST

			12-BROWN RECORDERS OFF/RETURN TO A JUMP CIRCUITS		INST CNTRL
X-2/14H	0019	*	READY POD 1 FOR HOT TEST & REPORT 31 MIN- 1- OPEN P.U. PURGE VALVE 2- CHECK A/P CANNISTER PREPARED FOR HOT FIRING A-SWS 1, 7 & 8 ON B-SWS 2, 3, 4, 5 & 6 OFF 3- INSTALL MAIN MISSILE BATTERY 4- CLOSE & SECURE POD DOORS		MISSILE POD 1 POD 1 POD 1 POD 1
	0020	*	REMOVE MECHANICAL LOCKS FROM STRETCH SLING & REPORT REMOVED X-1 DAY-		TS-STA55
X-2/04H	0021	*	CHECK LAUNCHER STABILIZING SYSTEM PRESS OK & REPORT 1- CHECK BOOSTER UNIT OUTLET PRESS/ 2000 PSIG MINIMUM 2150 PSIG- 2- CHECK PRESSURE LITES OUT	2000 PSIG	HYD PAD HD & R
X-2/04H	0022	*	CHECK WIND VELOCITY & REPORT-MAX 30 KTS 8 TO 13 KNOTS-		INST
	0023	*	CHECK ALL FIREX SWS OFF		FIREX
	0024	*	PREPARE FIREX SYSTEMS FOR TEST & REPORT X-1 DAY-		

~~CONFIDENTIAL~~

1- OPEN SKIRT FOG MANUAL SHUTOFF VALVE 312W — VLV PIT #3

2- SKIRT FOG MANUAL SELECTOR VALVE 323W TO FAIL-WET — G — VLV PIT #3 / FIREX

3- OPEN LAUNCHER COOLANT MANUAL SHUT-OFF VALVE 201W — VLV PIT #3

4- LAUNCHER COOLANT MANUAL SELECTOR VLV 212W TO FAIL-WET — G — VLV PIT #3 / FIREX

5- OPEN TOWER WATER MANUAL SHUTOFF VALVE 402W — VLV PIT #3

6- LOWER MISSILE WATER MANUAL SELECTOR VALVE 420W TO FAIL-WET — G — TS-STA17-R / FIREX

7- OPEN VERNIER DEFL MANUAL SHUTOFF VALVE 101W — VLV PIT #3

8- OPEN GAGE COCK 56W/CHECK VACUUM GAGE FOR PROPER VALUE/MIN 5.5 IN HG — VLV PIT #3

9- CLOSE GAGE COCK 56W — VLV PIT #3

0025 * CHECK NO PERSONNEL IN ELEVATOR — STAND

X-2/12H 0026 * SECURE SERVICE TOWER & UTILITY PANEL SDC2 — SDC BLDG

1- TURN OFF ELEVATOR POWER SW-13

//

HOLD 1451 TO 1505 - REMOVE GREASE FROM AROUND 62 THRUST CHAMBER GIMBAL MOUN — T

//

CONFIDENTIAL

CONFIDENTIAL

//

DELAY 1510-1525-SEX UP FLEXIBLE FIREWALL

//

X-1/43H	0027	*	PREPARE BOOSTER & SUS HYDRAULIC SYSTEMS FOR RUN	
			1- CHECK AUTOPILOT AC POWER SW ON	A AUTOPILOT
			A-CHECK PHASE ROTATION CORRECT	G PG AUX PN
			LIGHT ON	
			B-CHECK OUTPUT SW IN CUTOFF	A/P TST PG
			2- CHECK HEATER & REFRIGERATOR SWS OF	HYD CARTS
			3- CHECK LOCAL/REMOTE SWS TO REMOTE	HYD CARTS
			4- START BOOSTER GROUND PUMP	G HYDRAULIC
			5- CLOSE BOOSTER BYPASS VLV	G HYDRAULIC
			A-CK MSSL INLET PRESS/2000 PSIG	2000 PSIG
			B-CK MSSL OUTLET PRESS/75 PSIG MAX	75 PSI MX
			6- START SUS GROUND PUMP	G HYDRAULIC
			7- CLOSE SUS BYPASS VALVE	G HYDRAULIC
			A-CK MSSL INLET PRESS/2000 PSI	2000 PSIG
			B-CK MSSL OUTLET PRESS/75 PSIG MX	75 PSI MX
			8- CHECK MSSL HYD RESERVOIR FLUID	MISSILE
			LEVELS/ADJUST IF NECESSARY	
			9- OPEN BOOSTER BYPASS VALVE	A HYDRAULIC
			10-STOP BOOSTER GROUND PUMP	HYDRAULIC
			11-OPEN SUS BYPASS VALVE	A HYDRAULIC
			12-STOP SUS GROUND PUMP	HYDRAULIC

	13-A/P AC POWER SW OFF			AUTOPILOT
0028	* CHECK FACILITY SYSTEMS SUPPLY PRESS/RECORD & REPORT			
	CHECKED X-1 DAY-			
	1- POD COOLER OPERATION/APPROX 45F			COOLER PAD
	2- FUEL TRANSFER UNIT PNEU PRESS	110 PSI		FUEL PAD
	A-CHECK THE FUEL MANUAL VLVS OPEN			
	1-FILTER INLET VALVE 103RP			
	2-SUPPLY OUTLET VALVE 110RP			
	3-TRANSFER UNIT INLET VALVE 113 RP			
	3- PNEUMATIC BOOSTER SUPPLY PRESS	2200 PSIG		TS-STA17-R
	4- LAUNCHER GN2 SUPPLY PRESS-	2200 PSI		TS-STA17
	5- EMER LO2 PREVALVE CONTROL PRESS			TS-STA43
	A-SUPPLY MIN 1800 PSI-			
	B-REGULATED 1000 PSI-			
	6- PCU HELIUM SUPPLY PRESSURES			PRESS PAD
	A-NORMAL- 2025 PSIG			
	B-EMERGENCY - 2025 PSIG			
	C-BANK - MIN 3500 PSI - 4600 PSIG			
	7- OPEN A/S HE SUPPLY VALVE 213HE			PRESS PAD
	8- LO2 TRANSFER UNIT PNEU PRESS	110 PSI		LO2 PAD
	9- OPEN STORAGE TANK OUTLET VLV 101LX			LO2 PAD
	10-GN2 BANK PRESSURE	2200 PSIG		LO2 PAD
	11-CHECK PURGE MANIFOLD PRESS	1000 PSIG		PURGE BOX
	1000 +/- 50 PSIG			

1000 PSIG-

12-CHECK VALVE CONTROL PRESS — 400 PSIG — PURGE BOX

400 +/- 20 PSIG

400 PSIG-

13-CLOSE & SECURE PURGE BOX — PURGE BOX

14-REPORT EMER GEN FREQ & VOLT — BLKHS REAR

0029 * DEACTIVATE STAITCH SLING — TOWER

X-1 DAY-

1- CHECK LITE OUT — PRESS

0030 * MONITOR MISSILE VERTICAL ALIGNMENT /[illegible] — 15-0-15 — HD & R

LIMITS 15-0-15 MINUTES

X-1[illegible] 0031 * REMOVE FLAME DEFL COVERS & SAFETY NET & REPORT

X-270[illegible] 0032 * CHARGE CO2 FIREX SYSTEM

1- CHECK THAT POS 1, POS 2 & ENG CO2 — FIREX

CONTROLS FUNCTION & VLVS ACTUATE

2- CHECK THAT CO2 SYSTEM ELECTRO-MANUAL — TS-STA17

PILOT VLVS 100, 200 & 300 ARE CLOSED

PLUNGER DOWN & SOLENOID DE-ENERGIZED

3- CLEAR ALL PERSONNEL FROM THRUST — TEST STAND

SECTION

4- SLOWLY OPEN CO2 STORAGE UNIT DIS- — CO2 STORGE

CHARGE VLV AV1 TILL SYS FULLY CHARGED

5- CHECK CO2 HOSE REEL INLET VLV OPEN — TS-STA17

0033 * PRESSURIZE AIR FLASK TO 4000 PSIG & REPORT

X-1 DAY-

1- CK 7000 PSIG HELIUM RECEIVER PRESSURIZED	7000 PSIG	PNEU UNIT
2- CHECK HIGH PRESS SUPPLY VALVE 606K CLOSED		CHARGE PNL
3- CHECK PRESS REG 626K BACKED OFF		CHARGE PNL
4- CHECK PRESS REG 623K VENT CLOSED		CHARGE PNL
5- CHECK VENT VALVE 746K CLOSED		CHARGE PNL
6- CONNECT ACCUM PRE-CHARGE LINE (ETAL) AIR FLASK CHARGE PANEL & MISSILE FITTINGS		
7- OPEN FLASK PRESSURIZING VALVE 720K		CHARGE PNL
8- CHECK 7000 PSIG NITROGEN VENT VALVE CLOSED		PNEU UNIT
9- SLOWLY OPEN 7000 PSIG NITROGEN SHUTOFF VALVE		PNEU UNIT
10-SLOWLY OPEN HI PRESS SUPPLY VLV 606K		CHARGE PNL
11-ADJUST PRESS REG 626K TO PRESSURIZE FLASK TO 4000 PSIG	4000 PSI	CHARGE PNL
NOTE-PRESSURE TO BE READ ON PRE-CHARGE LINE PRESS GAGE		
12-CLOSE HIGH PRESS SUPPLY VALVE 606K		CHARGE PNL
13-OPEN VENT VALVE 746K TILL GAS FLOW CEASES/CLOSE		CHARGE PNL

SYC 8-2 1-8 RUN 4 AS RUT COUNTDOWN 14 JUL 58 PAGE 113

			14-CLOSE PRESSURIZING VALVE 7560		CHANGE PNL
			15-BACKOFF PRESS REG 626		CHANGE PNL
			16-CLOSE 7000 PSIG NITROGEN SHUTOFF VLV		PNEU UNIT
			17-OPEN 7000 PSIG NITROGEN VENT VLV		PNEU UNIT
			TILL GAS FLOW CEASES/CLOSE		
-1/..h	0034	*	ACTIVATE THRUST SECTION HEATING UNIT & REPORT		
			47 MIN - UNIT NOT OPERATING PROPERLY		
			FOUND TO VOID OF OIL & FILLED W/ KEROSENE		
			1- CHECK HEATING UNIT CONTROL SW TO		FACLTY PNL
			NEUTRAL		
			2- CHECK DUCTING PROPERLY SECURED TO		HEAT UNIT
			UNIT & TO MISSILE STRUCTURE		
			3- PULL BURNER FUEL VLV UP		HEAT UNIT
			4- START HEATING UNIT		HEAT UNIT
			5- HEAT UNIT CONTROL SW ON		FACLTY PNL
			6- DEPRESS BURNER START SW		HEAT UNIT
			7- SET AIR VOLUME CONTROL TO FULL		HEAT UNIT
			8- SET TEMP CONTROLLER TO MAX		HEAT UNIT
			9- MONITOR OUTLET TEMP TO APPROX 300F	300F	HEAT UNIT
X-08	0035	*	ACTIVATE HASKELL DIESEL COMPRESSOR & REPORT		
			NOT REQUIRED-		
			NOTE-THIS OPERATION TO BE PERFORMED ONLY IF		
			FACILITY SOURCE IS LESS THAN 3500 PSIG		
			1- CYCLE SW TO NEUTRAL		PRESS PNL

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

			2- THROTTLE CONTROL TO START		PRESS PAD
			3- START SW TO ON		PRESS PAD
			4- THROTTLE CONTROL TO RUN		PRESS PAD
			5- HYDRAULIC VALVE SELECTOR TO OPERATE		PRESS PAD
			6- LOCAL/REMOTE SW TO REMOTE		PRESS PAD
X-2/30M	0036	*	SECURE LAUNCHER #2 & REPORT		TS-STA5-R
			8 MIN-		
			1- ENGINE AC BREAKER SWS ON -3	SW	LCHR BOX 2
			2- CHECK LO2 HEATER LITS ON	A	LO2 CNTRL
			3- AREA CLEAR SW ON		LCHR BOX 2
			A-CHECK LITES ON	G	ENG TEST
				G	PRESTART
			4- SECURE LAUNCHER BOX 2 & CLOSE ALL VENT VALVES		TS-STA5-R
X-1/25M	0037	*	SET UP MISSILE TERMINAL BOX PURGES & REPORT		
			1- OPEN ELECTRICAL BOX & 2 PURGE VALVE 1378		TS-STA5-R
			2- CHECK PRESS REG 1566 SET FOR 3 INCH WATER		TS-STA5-R
X-1/0M	0038	*	FILL LN2 SHROUD		
			16 MIN-		
			1- CHECK LN2 STORAGE TANK PRESS/VENT SW TO VENT/HEAT EXCHANGER		PRESS PAD
			2- OPEN PRESS VALVE 312G		PRESS PAD

			2- THROTTLE CONTROL TO START		PRESS PAD
			3- START SW TO ON		PRESS PAD
			4- THROTTLE CONTROL TO RUN		PRESS PAD
			5- HYDRAULIC VALVE SELECTOR TO OPERATE		PRESS PAD
			6- LOCAL/REMOTE SW TO REMOTE		PRESS PAD
X-2/30H	0036	*	SECURE LAUNCHER #2 & REPORT		TS-STA5-R
			8 MIN-		
			1- ENGINE AC BREAKER SWS ON -3	SW	LCHR BOX 2
			2- CHECK LO2 HEATER LITS ON	A	LO2 CNTRL
			3- AREA CLEAR SW ON		LCHR BOX 2
			A-CHECK LITES ON	G	ENG TEST
				G	PRESTART
			4- SECURE LAUNCHER BOX 2 & CLOSE ALL VENT VALVES		TS-STA5-R
X-1/25H	0037	*	SET UP MISSILE TERMINAL BOX PURGES & REPORT		
			1- OPEN ELECTRICAL BOX GN2 PURGE VALVE 1373N		TS-STA5-R
			2- CHECK PRESS REG 1369N SET FOR 3 INCH WATER		TS-STA5-R
X-1/0:H	0038	*	FILL LN2 SHROUD		
			16 MIN-		
			1- CHECK LN2 STORAGE TANK PRESS/VENT SW TO VENT/HEAT EXCHANGER		PRESS PAD
			2- OPEN PRESS VALVE 3120N		PRESS PAD

			3- CLOSE 3 INCH TANK VENT VALVE 302LN		PRESS PAD
			4- SET PRESS REG 306GN TO 40 +/- 4 PSIG	40 PSIG	PRESS PAD
			PRESS GAGE 310GN-4		
			5- OPEN LN2 PUMP VALVE FOR 15 SEC-CLOSE	G-OUT	PNEUMATIC
			A-CHECK VALVE OPERATION/ 2 VALVES		TEST STAND
			6- OPEN LN2 FLUSHING WATER VALVE		STAND
			7- DEPRESS LN2 PRECOOL SW-WAIT 10 MIN	DG	PNEUMATIC
			8- DEPRESS PRESSURIZE SW	G	PNEUMATIC
			A-CHECK LN2 SUPPLY PRESS/20 PSIG	20 PSIG	PNEUMATIC
	0039	*	CHECK PURGE PANEL POWER SW OFF		PURGE
X-1/54M	0040	*	PERFORM ENGINE CUTOFF CHECK		
			1- OBSERVER DEPRESS ENG CUTOFF SW		
			A-CHECK CUTOFF LITES ON	3R	ENG CNTRL
			B-CHECK EA PEN 153 FOR RESPONSE		INST
			P1223X DAY 0127		
			2- ENGINE RESET TO RESET		ENG TEST
X-1/49M	0041	*	CHECK RCC SYSTEM FOR CONTINUITY		
			1- MISSILE INVERTER SW ON		MSSL POWER
			2- AUDIBLY CHECK CHANNELS 32, 33 & 34		ELCTRNC RM
			FOR NOISE/EARPHONES		
			3- MISSILE INVERTER SW OFF		MSSL POWER
			4- RESET RCC CHANNELS 32, 33 & 34		ELCTRNC RM
			5- INACTIVE/ACTIVE SWS TO ACTIVE ->	3R	C1 COUNTER
X-52 M	0042	*	NOTIFY SECURITY - COUNTDOWN WILL START		

IN APPROXIMATELY 15 MIN

0043 * CHECK TUNNEL ESCAPE HATCH CLOSED TEST AREA

(- 42 h 0044 * ALL PERSONNEL TO BLOCKHOUSE, TEST PERSONNEL
CLEAR TRANSFER ROOM/SECURITY CHECK ALL PRESENT
THEN SECURE BLOCKHOUSE DOORS

CONFIDENTIAL

COUNTDOWN OPERATIONS

X- 35 0045 * PA ANNOUNCEMENT - START OF COUNTDOWN - TIME IS X-35 MIN

X- 34 0046 * SET AREA IN CONDITION RED

X- 30 0047 * REPORT IF SYSTEM READY OR TURN ON AS LISTED WHEN CALLED OUT

1- FACILITY POWER - READY

2- FLAME DEFLECTOR - READY

3- MISSILE POWER - READY

4- ENGINE TEST - READY

5- LO2 SYSTEM - READY

6- FUEL SYSTEM - READY

7- PURGE - READY/PANEL POWER OFF

8- HOLD DOWN & RELEASE - READY

9- PRESSURIZATION - READY

10-PNEUMATIC - READY

11-HYDRAULIC - READY

12-AUTOPILOT - READY

13-INSTRUMENTATION - READY

14-RCC - READY

15-TEST CONDUCTOR CONSOLE - READY

16-OBSERVERS - READY

A-NORTH TANK

B-SOUTH TANK

C-BLOCKHOUSE

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

X-37 M	0048	*	START BOOSTER & SUS HYD SYSTEMS		
			1- AUTOPILOT AC POWER ON O/I	G	AUTOPILOT
			2- BOOSTER GROUND PUMP ON	G	HYDRAULIC
			3- CLOSE BOOSTER BYPASS VALVE	G	HYDRAULIC
			A-CK MSSL INLET PRESS/2000 PSI	2000 PSI	
			B-CK MSSL OUTLET PRESS/75 PSI MX	75 PSI MX	
			4- SUS GROUND PUMP ON	G	HYDRAULIC
			5- CLOSE SUS BYPASS VALVE	G	HYDRAULIC
			A-CK MSSL INLET PRESS/2000 PSI		
			B-CK MSSL OUTLET PRESS/75 PSI MX		
			//		
			HOLD 1602 TO 1608 - INCREASE SUS HYD RETURN		
			PRESS - WAS 7 PSIG - INCREASED TO 33 PSIG		
			//		
X-30	0049	*	FILL MISSILE HELIUM BOTTLES		
			1- CHECK S & G SHROUD LITES CYCLED		PNEUMATIC
			2- BRING RECORDERS ON SLOW		INST CNTRL
			F1124P C/Y D216-2		
			F1145P C/Y D216-1		
			3- DEPRESS HELIUM STORAGE B/I	G	PNEUMATIC
			4- REPORT PRESS AT 500 PSI INTERVALS		INST
			5- REPORT WHEN PRESSURE REACHES 3000PSI		INST
			NOTE-IF BOTTLE PRESSURE OF 3000 PSIG CAN		
			NOT BE ATTAINED FROM FACILITY SOURCE		

CONFIDENTIAL

			A-COMPRESSOR CYCLE/READY SW TO CYCL	S	PNEUMATIC
X-19	0050	*	DEPRESS PRESS SEQUENCE NO 2 SW	26	PRESS
			1- MONITOR MISSILE FUEL TANK PRESS		PRESS
			TO 30 PSI REPORT WHEN PRESS COMPLETE		
X-09	0051	*	SET UP LO2 PANEL FOR OPERATION		
			1- CHECK SEW 2 TANK PRESS LITE ON	W	LO2 CNTRL
			2- CHECK VLV CONTROL PRESS LITE ON	W	LO2 CNTRL
			3- PANEL OPERATIONAL POWER SW ON	A	LO2 CNTRL
	0052	*	VIBRATRON PRINTOUT SW TO OPERATE		INST
X-17	0053	*	LO2 TANKING RECORDERS ON SLOW/CIRCUIT		INST CNTRL
			E JUMP POSITION		
			1- BROWNS		
			F1001P BAY D121-2 P1021T BAY D124-2		
			F1003P BAY D119-2 ST160T BAY D124-1		
			M1011F BAY D107-1 ST161T BAY D124-1		
			P1014T BAY D220-2 ST162T BAY D124-1		
			P1020T BAY D115-1 ST163T BAY D124-1		
			P1126T BAY D116-1 ST164T BAY D124-1		
			P1127T BAY D116-2 ST165T BAY D124-1		
			P1209T BAY D118-2 ST160T BAY D124-2		
			P1213T BAY D116-1 ST166T BAY D124-2		
			P1323T BAY D116-3 ST169T BAY D124-2		
			P1324T BAY D116-3 ST170T BAY D124-2		
			2- BAS- RECORDERS 3 & 4 BAY 0127/LOCALLY		

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

X-29	0054	*	CHILLDOWN LO2 SYSTEM FOR TANKING	
			1- CLOSE RETURN VALVE	LO2 CNTRL
			2- OPEN PUMPS LA & LB OUTLET VLVS	LO2 CNTRL
			3- CHECK PUMP LO THROTTLE VALVE FULL OPEN/PANEL METER	LO2 CNTRL
			4- LO2 TANK PRE-FILL SW ON	LO2 CNTRL
				PRESS
			5- OPEN LO2 PRE-VALVE	LO2 CNTRL
			6- OPEN LO2 FILL & DRAIN VALVE	LO2 CNTRL
			7- OPEN PUMP OUTLET VALVE	LO2 CNTRL
			8- OPEN PUMP INLET VALVE	LO2 CNTRL
			9- CLOSE STORAGE TANK VENT VLV	LO2 CNTRL
			10-OPEN STORAGE TANK PRESS VLV	LO2 CNTRL
			A-MONITOR STORAGE TANK PRESS TO APPROX 25 PSIG	LO2 CNTRL
			11-MONITOR MSSL LO2 TANK PRESS / 10 PSIG MAX	PRESS
			NOTE-IF LO2 TANK PRESSURE EXCEEDS 10 PSIG OPEN EMERGENCY DUMP VALVE OR BLEED VALVE & LOWER TANK PRESS/CLOSE	
			12-OPEN RETURN VALVE 10 SEC/CLOSE	LO2 CNTRL
			13-OBSERVERS REPORT LO2 BOIL-OFF VALVE OPERATION	TANKS
			14-REPORT WHEN LIQUID IS INDICATED	INST

CONFIDENTIAL

CONFIDENTIAL

			AT P1021T BAY D123-2		
			15-RESET LO2 DIGITIZER		
			16-CLOSE PUMP LA & LB OUTLET VLVS	2W	LO2 CNTRL
			17-START PUMP LC	A	LO2 CNTRL
X-22		0055	* WHEN VIBRATION INDICATES LO2 IN MISSILE		INST
			INCREASE FLOW		
			1- OPEN PUMP LA & LB OUTLET VLVS	A	LO2 CNTRL
			2- START PUMPS LA & LB		LO2 CNTRL
			A-CHECK PUMP LB ON, THEN PUMP LA	2A	
			B-CHECK PUMP LC STOP/AUTO		
			3- OPEN PUMP LC BYPASS VALVE	A	LO2 CNTRL
			4- REPORT TANK LEVEL _ 20 IN INTERVALS/		INST
			VIBRATION		
			5- MONITOR MSCL LO2 TANK PRESS /	10 PSI MX	PRESS
X-25		0056	* LO2 TANKING RECORDERS ON, SLOW/CIRCUIT		INST CNTRL
X-22	M	0057	* ACTIVATE PU VALVE CONTROL PROGRAMMER & REPORT		
			1- ROLL SW OFF		INST
			2- 400 CYCLE SW ON		INST
			3- 28 VDC SW ON		INST
			4- SIGNAL DC/400 CYCLE SW TO DC		INST
			5- STEP SW TO CYCLE START		INST
			6- CHECK STEPPING SW ROTOR SET AT START		INST
			OF PROGRAM		
			7- CONNECT THE BLACK & RED UMBILICAL JACKS		INST

			TO THE CORRESPONDING PLUGS ON PROGRAMMER		
X-22	0058	*	PERFORM ENGINE GIMBALING PROGRAM		
			6 MIN-		
			1- CHECK ARMED/SAFE SW TO SAFE	A	AUTOPILOT
			2- ENGINE CUTOFF LOCKOUT SW ON		A/P PG BAS
			3- GIMBAL THE BOOSTER SUS & VERNIER		
			THRUST CHAMBERS AT 1 DEG & 1/2 CPS FOR APPROX		
			5 MIN TO PREVENT SERVO VALVE MALFUNCTION		
			4- CHECK PRESSURIZING TIMER SET	87 SEC	AUTOPILOT
			FOR 87 SEC		
			5- CHECK SUS CUTOFF TIMER SET FOR	7 SEC	AUTOPILOT
			7 SEC		
			6- AFTER PROGRAMMER HAS RECYCLED, ENG		A/P PG BAS
			CUTOFF LOCKOUT SW OFF		
X-16	0059	*	NOTIFY SECURITY-COUNTDOWN TIME IS NOW		
			APPROX 10 MIN		
X-15	0061	*	CHECK GIMBALING PROGRAM COMPLETE		
	0061	*	CAMERAS POWER SW ON/BUTTON LIGHT DAY 0102		INST CNTRL
	0062	*	SANBORN RECORDERS TO USE POSITION		INST
X-15	0063	*	CHECK ENG TIMERS READY		ENG TIMER
			1- CHECK S ENG TIMER SET FOR 105 SEC	105 SEC	
			A-BOOSTER TIMER SW ON		
			2- CHECK SUS ENG TIMER SET FOR 199 SEC	199 SEC	
			A-SUS TIMER SW ON		

CONFIDENTIAL

SYC S-2 1-3 RUN 4 AS RUN COUNTDOWN 14 JUL 58 PAGE 025

			3- CHECK V ENG TIMER SET FOR 217.5 SEC	217.5 SEC	
			A-VERNIER TIMER SW ON		
			4- ENGINE TIMER SW TO READY	G	ENG TIMER
X-15		0064	* TURN ON PF SYSTEMS & REPORT		MSSL POWER
			1- AZUSA ON		MSSL POWER
			2- DOVAP ON		MSSL POWER
			3- GE SELECTOR SW TO ON		MSSL POWER
			A-CHECK FILAMENT LITE ON	A	
			B-AFTER 3 MIN CK FULL POWER LITE ON	G	
			C-CHECK FILAMENT LITE OFF		
		0065	* AC METER SELECTOR SW TO INT		MSSL POWER
X-14		0066	* MISSILE INVERTER SW ON	W	MSSL POWER
			1- CHECK OUTPUT AT 115V AC & 400 CYCLES	115V AC	MSSL POWR
			2- USING AC METER SELECTOR SW - ADJUST EXT VOLT & FREQ TO MATCH INVERTER OUTPUT		MSSL POWR
X-14		0067	* ALL CONTROLS SATISFACTORY CHECK-REPORT		
			1- FACILITY POWER		
			2- FLAME DEFLECTOR		
			3- MISSILE POWER		
			4- ENGINE TEST		
			5- LO2		
			6- FUEL		
			7- PURGE		
			8- HOLD DOWN & RELEASE		

9- PRESSURIZATION
10-PNEUMATIC
11-HYDRAULIC
12-AUTOPILOT
13-INSTRUMENTATION
14-RCC
15-OBSERVERS
A-NORTH TANK
B-SOUTH TANK
C-BLOCKHOUSE
16-TEST CONDUCTOR

Y-12 0066 * ALL BRANCHES ON SLOW- THE FOLLOWING INST CNTRL

MEASUREMENTS HAVE JUDGEMENT REQUIREMENTS

MEAS NO	DESCRIPTION	DAY NO	LL	UL UNITS
P1528D	SUS PU VLV POSITION	D108-2	26	DEG
P1030P	VERNIER LO2 TANK	D109-1	500	540 PIG
P1236P	VERN LO2 TK REG OUT	D109-2	310	330 PIG
P1489P	2 GAS GEN LO2 VLV I	D109-3	430	470 PIG
P1027P	VERNIER FUEL TANK	D110-1	515	555 PIG
P1236P	VERN FUEL TK REG OUT	D110-2	320	340 PIG
P1075P	2 FUEL START TANK	D110-3	760	840 PIG
P1026P	2 LO2 REG REFERENCE	D111-2	310	330 PIG
P1176P	2 FUEL START TANK REG	D111-3	760	840 PIG
P1044P	2 LO2 REG REFERENCE	D112-2	600	620 PIG

P1177P	B LO2 START TANK REG	D113-3	430	470	PIG
H1033P	B1 HYD ACCUMULATOR	D114-1	1500	4000	PIG
P1126T	B1 LO2 PUMP OTBD BRG	D116-1	-60	300	DGF
P1127T	B2 LO2 PUMP OTBD BRG	D116-2	-60	300	DGF
P1324T	S PUMP BEARINGS-LO2	D116-3	-60	300	DGF
P1336T	S GAS GEN DISCHARGE	D117-2		1400	DGF
P1213T	B1 TURBINE BEARING	D118-1		750	DGF
P1209T	B2 TURBINE BEARING	D118-2		750	DGF
P1323T	S TURBINE BEARING	D118-3		750	DGF
A1388T	ENG COMP AFT AMB Q3	D125-1		800	DGF
A1389T	ENG COMP AFT AMB Q4	D125-1		800	DGF
H1052P	S HYD ACCUMULATOR	D214-1	1500	4000	PIG
A1387T	ENG COMP AFT AMB Q2	D125-1		800	DGF
A1386T	ENG COMP AFT AMB Q1	D125-2		800	DGF
E1026V	MSL SYSTEMS INPUT	D221-2	26	29	VDC
P1014T	ENGINE COMP AMBIENT	D220-2	45		DGF
THE FOLLOWING MEASUREMENTS HAVE REDLINE INDICATIONS					
A1264D	MSL TK MOVEMENT X AX	D107-2		2.25	IN
A1266D	MSL TK MOVEMENT Y AX	D107-3		2.25	IN
F1125P	B CTL PNEU REG	D111-1	735	765	PIG
F1142P	S CTL PNEU REG OUT	D113-1	735	765	PIG
F1003P	FUEL TANK HELIUM	D119-2	53	66	PIG
	AFTER BOOSTER STAGING		45		PIG
P1332P	S LO2 PUMP DISCH	D119-3		1050	PIG

		F1001P	LO2 TANK HELIUM	D121-2	22	27 PIG	
		ST206P	S LUB PUMP BRG	D212-2	30	PIG	
		F1145P	S CTL HE BTL DISCH	D216-1	1800	3500PIG	
		F1124P	S TK HE BTL DISCH	D216-2	400	3500PIG	
		F1121P	S CTL HE BTL DISCH	D217-1	800	3500PIG	
		F1005P	S TK HE BTL DISCH	D217-2	400	3500PIG	
		P1010P	S1 LUB OIL TANK	D218-1	550	PIG	
		P1011P	S2 LUB OIL TANK	D218-2	550	PIG	
		P1341P	S LUB PUMP GEAR	D218-3	400	PIG	
		P1017T	S2 TURBINE IN	D220-3		1400DGF	
		P1018T	S1 TURBINE IN	D221-3		1400DGF	
		L1257T	FLAME DEFLECTOR	D223-1		1800DGF	
		L1259T	FLAME DEFLECTOR	D223-2		1800DGF	
		L1263T	FLAME DEFLECTOR	D223-3		1800DGF	
A-3	0069	*	NOTIFY SECURITY THAT COUNTDOWN TIME IS .				
			NOW APPROX 5 MIN				
	1070	*	CHEK PU NULL METER READS 0.5 OR				INST
			ST219F-BAY 207-1 INDICATES 102,000 LB LO2				LO2 CNTRL
			1- STOP PUMPS LA & LB				LO2 CNTRL
			2- START PUMP LC		A		LO2 CNTRL
			3- CLOSE PUMP LC BYPASS VALVE		W		LO2 CNTRL
			4- CLOSE PUMP LA & LB OUTLET VALVES		2W		LO2 CNTRL
			5- MAN RECORDER P1011F				INST
A-3	1071	*	CHEK FULL TANK PROBE LITE COMES ON				LO2 PANEL

CONFIDENTIAL

CONFIDENTIAL

			1- STOP PUMP LC		LO2 CNTRL
			2- CLOSE FILL & DRAIN VALVE	W	LO2 CNTRL
			3- OPEN RETURN VALVE	A	LO2 CNTRL
			4- TANK FILLED SW ON	G	LO2 CNTRL
				G	PRESS
	0071	*	SECURE LO2 SYSTEM & REPORT		LO2 CNTRL
			1- CLOSE PUMP INLET VALVE	W	LO2 CNTRL
			2- OPEN EMERGENCY DUMP VALVE	R	LO2 CNTRL
			3- CLOSE STORAGE TANK PRESS VLV		LO2 CNTRL
			4- TEST POSITION KEY ON		LO2 CNTRL
	0072	*	REPORT & RECORD MISSILE WEIGHT		INST
			M1011F BAY 0107-1		
			1- REPORT VIBRATION READINGS	INST	
	0074	*	C&C RECORDERS TO REMOTE		INST
-3	0075	*	DEPRESS PRESS SEQUENCE TO 3 SW	2G	PRESS
X-4	0076	*	START MAIN FLAME DEFL WATER FLOW & REPORT		
			1- COOLANT VLV BREATHER SW ON/ OVERIDE PANEL		FACLTY PWR
			2- MAIN FLAME DEFL SW ON	G	FLAME DEFL
			3- OPEN THROTTLE VALVE 100%	100%	FLAME DEFL
			4- MONITOR WATER FLOW		SOUTH TANK
			5- MONITOR MAIN DEFL PRESS/70-90 PSI		INST
			L1161P BAY 0106-1		
-4	0077	*	START VERNIER FLAME DEFL WATER FLOW & REPORT		

SYC -2 1-3 RUN- 4 AS RUN COUNTDOWN 14 JUL 58 PAGE 030

			1- VERNIER DEFL SW OFF	G	FLAME DEFL
			2- MONITOR MANIFOLD PRESS/ TM 18 PSIG	18 PSIG	FLAME DEFL
			3- WATER SYSTEMS READY SW ON	G	FLAME DEFL
				G	PRESTART
	0078	*	VERNIER LO2 VENT SW TO VENT/INST	G	ENG CNTRL
			MONITOR VERNIER BLEED	2G	INST
			DAY D101		
	0079	*	LN2 DUMP VLV SW TO OPEN/OBSERVERS REPORT	G	PNEUMATIC
	0080	*	MISSILE POD COOLER SW OFF		FACLTY PWR
	0081	*	THRUST SECTION HEATER SW OFF		FACLTY PWR
	0082	*	LAUNCH COOLANT AUTO/OFF SW TO AUTO		FIREX
	0083	*	30 MIN CAMERAS ON		INST CNTRL
	0084	*	CHECK MISSILE BOTTLE PRESSURE- 3000 PSIG	3000 PSIG	INST
			3100 PSIG-		
			F1005P DAY D217-2		
			F1124P DAY D213-2		
			F1121P DAY D217-1		
			F1145P DAY D216-1		
	0085	*	PREPARE AUTOPILOT TEST PROGRAMMER FOR RUN 6 REPORT		
			1- CHECK ENGINE CUTOFF LOCKOUT SW OFF		A/P PG BAS
			2- CK A/P ARMED/SAFE SW TO SAFE		AUTOPILOT
			3- CHECK A/P DISCRETE SW TO AUTO		AUTOPILOT
			4- CHECK TAPE POSITION IN READER		A/P TST PG
			5- READER SEL SW TO REMOTE		A/P TST PG

CONFIDENTIAL

CONFIDENTIAL

			6- MODE SELECTOR TO AUTO/READ		A/P TST PG
			7- MANUAL/AUTO SW TO AUTO		A/P TST PG
			8- LADER SW ON		A/P TST PG
			9- MOTOR SW ON		A/P TST PG
			10-RECORDERS ZERO INDICATION ON	G	A/P AUX PN
			11-A/P READY SW ON	G	AUTOPILOT
				G	PRESTART
-1/20.	0086	*	ENGINE TEST/RUN SW TO RUN/CHECK	G	ENG CNTRL
			ENGINE PUMP COMPLETE LITE ON	G	ENG TEST
-1/.	0087	*	REPORT MISSILE VERTICAL ALIGN AT/OR	15-0-15	HD6 R
			LIMITS 15-0-15 MINUTES		
-1/..	0088	*	CHECK 1 & 3 HYDRAULIC PRESS	2000 PSI	HYDRAULIC
			H1033P GAY D114-1		INST
			H1032P GAY D214-1		
-1/40	0089	*	OBSERVERS REPORT FLAME DEFLECTOR WATER		SOUTH TANK
-1/1.	0090	*	MISSILE AC POWER SOURCE SW TO INT	G	MISSL POWR
			1- CHECK LITE ON PRESTART PANEL	G	PRESTART
.-1/10.	0091	*	AUTOPILOT OUTPUT SW TO ON		A/P TST PG
-1/0.	0092	*	CHECK ENGINES FOR ZERO POSITION		A/P AUX PN
.-1/05.	0093	*	OBSERVERS REPORT LO2 VAPORS FROM		TANKS
			VENT IN FLAME DEFLECTORS		
.-0. .	0094	*	OPEN LO2 FILL & DRAIN VALVE UNTIL FULL		LO2 CNTRL
			METER READS-1.10%/CLOSE - CHECK FULL		
			METER READS-1.40% AFTER VALVE IS CLOSED		

CONFIDENTIAL

			27 SEC DUMP TO MISSILE ST. 919 -		
			1- INST MARK N1012F & RECORD VIBROTRON LEVEL		INST
X-2	0095	*	MISSILE SUPPLY SW TO INTERNAL		PNEUMATIC
			1- INST MONITOR TANK PRESSURES		INST
			F1001P DAY D141-2		
			F1002P DAY D119-2		
X-20	0096	*	CHECK FUEL TANK PRESSURES SATISFACTORY		PRESS
X-20	0197	*	PRESSURIZATION COMPLETE SW ON		PRESS
X-20	009	*	TURN ALL INSTRUMENTATION ON		INST
			1- ALL RECORDERS ON		
			A-EAS - FAST		
			B-CECS - FAST		
			C-BROWNS - FAST		
			D-SANBORNS - FAST		
			E-ALL TAPES ON		
			2- ALL CAMERAS ON		INST CNTRL
			3- SENSITIVITY RESET		
X-1	0099	*	CHECK PRESTART FOR ALL GREEN LITES	15G	PRESTART
X-1	010	*	CHECK MISSILE PREP COMPLETE LITE ON	G	ENG CNTRL
X-1	0102	*	DEPRESS START		ENG CNTRL
				Y	ENG TEST
X-1	010	*	ENG COOL WATER ON/OFF	R	FIREX
X-1	0103	*	REPEAT START TIME TO ...		INST

CONFIDENTIAL

CONFIDENTIAL

P1027P DAY 0110-1
P1030P DAY 0109-1
P1076P DAY 0110-1
P1469P DAY 0109-1

	0104	*	PURGE PANEL POWER SW ON		PURGE
	0105	*	FASTEX 1 & TRANS CAMERAS ON		INST CNTRL
	0106	*	VERIFY ENGINE FAIL		
			//		
			THE FOLLOWING STEPS TO LC2 RETARGETING		
			ARE SCHEDULED ITEMS. DAMAGE OF THE		
			FIRE, & EMERGENCY PROCEDURES WERE USE	D	
			TO EXTINGUISH THE FIRE & TO DECREASE		
			THE HAZARDOUS CONDITION OF THE MISSILE.		
			//		
	0107	*	REPORT MISSILE SUPPLY PRESS CHANGEOVER	SG	PNEUMATIC
	0108	*	MAIN ENG COMPLETE LITE ON/AUTO	G	ENG CNTRL
	0109	*	P.U. VLV PROGRAMMER START SW TO		INST
			START/IDENTIFY/BACK TO GO TO POSITION		
	0110	*	SET NO FASTEX CAMERAS ON		INST CNTRL
	0111	*	BOOSTER STAGING/FLIGHT PROGRAMMER		AUTOPILOT
			1- CHECK BOOSTER CUTOFF LITES ON	R	ENG CNTRL
				R	ENG TEST
			2- CHECK BOOSTER PURGES ON/AUTO	R	PURGE
			3- CHECK STAGING SIMULATION VLV OPEN	G	PNEUMATIC

			4- CHECK LAUNCH COOLANT ON/AUTO	G	FIREX
			5- ENG CO2 SW ON/10 SEC/OFF		FIREX
	0112	*	LAUNCH COOLANT AUTO/OFF SW TO OFF		FIREX
XM130 S	0113	*	A/P ARMED/SAFE SW TO ARMED		AUTOPILOT
XM100 S	0114	*	VERNIER TANKS PRE-PRESSURIZED/AUTOPILOT TIMER		
			P1027P DAY D110-1		INST
			P1030P DAY D109-1		
XM107 S	0115	*	SUSTAINER STAGING/AUTOPILOT TIMER		AUTOPILOT
			1- CHECK SUS CUTOFF LITES ON	R	ENG CNTRL
				R	ENG TEST
			2- CHECK SUSTAINER PURGES ON/AUTO	R	PURGE
			3- CLOSE FUEL PRE-VALVES	2	FUEL TNKNG
			4- CLOSE LO2 PREVALVE	A	LO2 CNTRL
			5- OPEN LO2 FILL & DRAIN VLV	A	LO2 CNTRL
			6- ENG CO2 SW ON/10 SEC/ OFF		FIREX
XM120 S	0116	*	VERNIER CUTOFF/FLIGHT PROGRAM		AUTOPILOT
CUTOFF			1- CHECK VERNIER CUTOFF LITES ON	R	ENG CNTRL
				R	ENG TEST
CUTOFF			2- CHECK VERNIER PURGES ON/AUTO	R	PURGE
CUTOFF			3- REPORT MSSL SUPPLY PRESS CHANNEL OVER	4A	PNEUMATIC
CUTOFF			4- DEPRESSURIZE MISSILE TANKS TO		PRESS
			SEQUENCE 2/REPORT WHEN COMPLETE		
			MANIFOLD PRESS REACHES 0 UNTIL FUEL		PRESS
			TANK PRESS STARTS TO DECREASE		

CONFIDENTIAL

			IGNITION FUEL TNK PRESS TO 30 PSIG	30 PSIG	PRESS
CUTOFF			5- VERNIER FLAME DEFL SW OFF	A	FLAME DEFL
			6- START 1 SECOND TIME CALLOUT		
	0117	*	MCC INACTIVE/ACTIVE SYS TO INACTIVE		ELCTRNC NW
	0118	*	MSSL PRE SW TO DUMP/REPORT WHEN 0 PSI		PNEUMATIC
	0119	*	MISSILE SUPPLY SW TO EXT	A	PNEUMATIC
	0120	*	ENGINE TIMER SWS TO OFF/4 SYS		ENG TIMER
	0121	*	ENGINE TEST/ARM SW TO TEST		ENG CNTRL
	0122	*	ENGINE TEST SELECTOR TO COMPONENTS		ENG TEST
	0123	*	DC POWER SOURCE SW TO EXTERNAL	A	MSSL POWR
	0124	*	AC POWER SOURCE SW TO EXTERNAL	A	MSSL POWR
	0125	*	MISSILE INVERTER SW OFF		MSSL POWR
	0126	*	SECURE INSTRUMENTATION		INST
			1- ALL RECORDERS OFF		INST CNTRL
			2- AM TAPES STOP SW ON		INST CNTRL
	0127	*	VERNIER LOX VENT SW TO CLOSE		ENG CNTRL
	0128	*	CHECK L G S HYDRAULIC PRESSURE	2000 PSIG	HYDRAULIC
	0129	*	TURN OFF RF SYSTEMS		MSSL POWER
			1- AZUSA OFF		MSSL POWER
			2- LOVAR OFF		MSSL POWER
			3- G.E. SELECTOR SW TO OFF		MSSL POWER
	0130	*	MISSILE POD COOLANT SW OFF	A	FACLTY PWR
	0131	*	THRUST SECTION HEATER SW TO NEUTRAL		FACLTY PWR
	0132	*	WATER SYSTEMS READY SW OFF		FLAME DEFL

0133	*	SECURE A/P TEST PROGRAMMER & REPORT	AUTOPILOT
		1- A/P OUTPUT SW TO CUTOFF	
		2- READER SW OFF	
		3- MOTOR SW OFF	
		4- READER SELECTOR SW TO LOCAL	
		5- MODE SELECTOR SW TO OFF	
		6- A/P ARMED/SAFE SW TO SAFE	
		7- ENGINE CUTOFF LOCKOUT SW ON	
0134	*	ENGINE RESET SW TO RESET	ENG TEST
0135	*	OBSERVERS REPORT CONDITION OF STAND & MISSILE	
0136	*	SECURE MAIN FLAME DEFL SYSTEM & REPORT	
		1- MAIN DEFL SW OFF	FLAME DEFL
		2- AFTER 30 SEC/COOLANT VLV BREATHER SW OFF/OVERIDE PANEL	FACLTY PWR
		3- THROTTLE VLV SW TO CLOSE/30 SEC/STOP	FLAME DEFL
		4- WATER SYSTEM READY SW OFF	FLAME DEFL
		5- PANEL POWER SW OFF	FLAME DEFL
0137	*	DIESEL SW TO [illegible]	PNEUMATIC
0138	*	CAMERAS [illegible] OFF	INST CNTRL
0139	*	DROWN RECORDER P10217 ON/JAY D123-2	INST
0140	*	DRAIN MISSILE LO2 TANK	
		1- OPEN PUMP INLET VALVE A	LO2 CNTRL
		2- REPORT [illegible] LIQUID INDICATED ON [illegible]	LO2 CNTRL
		[illegible] FLO [illegible]	

CONFIDENTIAL

	3- CLOSE EMERGENCY DUMP VLV		LO2 CNTRL
	4- OPEN STORAGE TANK VENT VALVE		LO2 CNTRL
	5- TANK FILLED SW OFF		LO2 CNTRL
	6- OPEN LOX PREVALVE	G	LO2 CNTRL
	7- MONITOR MISSILE LO2 TANK PRESSURE _ PSIG	2 PSIG	PRESS
0141	LAUNCHER COOLANT SW OFF		FIREX
0142	RESET ENGINE PURGES - 3 SEC PURGES DID NOT COME ON -		PURGE
0143	SECOND RCC SYSTEM REPORT		ELCTRNC RM
	1- RECORD COUNT & RESET RCC -3 CHANNELS		
	2- CHANNEL 32		
	A-RCC DEVICE POWER SW OFF		
	B-BINARY COUNTER POWER SW OFF		
	C-STEPPING SW COUNTER POWER SW OFF		
	D-MAIN POWER SW OFF		
	3- CHANNEL 33		
	A-RCC DEVICE POWER SW OFF		
	B-BINARY COUNTER POWER SW OFF		
	C-STEPPING SW COUNTER POWER SW OFF		
	D-MAIN POWER SW OFF		
	4- CHANNEL 34		
	A-RCC DEVICE POWER SW OFF		
	B-BINARY COUNTER POWER SW OFF		

C-STEPPING SW [illegible] POWER [illegible] OFF
[illegible] POWER SW OFF
[illegible] I STRUMENTATION PERFORM POST [illegible] INST
CALIBRATIONS & REMOVE RECORDS
0145 SECURE [illegible] HYD SYSTEMS & REPORT
1- OPEN BOOSTER BYPASS VLV [illegible] HYDRAULIC
2- STOP BOOSTER GROUND PUMP HYDRAULIC
3- OPEN SUS BYPASS VLV A HYDRAULIC
4- STOP SUS GROUND PUMP HYDRAULIC
5- [illegible] POWER SW OFF AUTOPILOT
0146 NOTIFY S-1 PERSONNEL/AREA CLEAR TO RETURN TO WORK
0147 [illegible] LO2 TANK LEVEL DROPS TO STA [illegible] INST
VIA ATTACH OF LIQUID IS NO LONGER INDICATED
AT P1021T/ SECURE LO2 SYSTEM
1- CLOSE PUMP INLET VALVE [illegible] LO2 CNTRL
2- OPEN [illegible] VALVE A LO2 CNTRL
3- MONITOR LO2 TANK PRESS/2 PSIG PRESS
4- INST REPORT WHEN LIQUID IS NO LONGER INST
INDICATED AT P1021T OR HELIUM FLOW PRESS
TO LO2 TANK IS [illegible]
5- CLOSE LO2 PREVLVS [illegible] LO2 CNTRL
6- PRE-FILL SW OFF LO2 CNTRL
7- CHECK LO2 VALVE [illegible] LIGHT ON A LO2 CNTRL
8- [illegible] INST

CONFIDENTIAL

CONFIDENTIAL

		NOTE - TEST POSITION KEY TO PROVIDE OPERATIONAL POWER UNTIL C85 HRS		LO2 CNTRL
01[illegible]	*	SET UP FUEL PANEL FOR MISSILE DETANKING		
		1- TEST POSITION KEY ON	A	FUEL TNKNG
		2- CLOSE PUMP OUTLET VALVE	A	FUEL TNKNG
		3- OPEN PUMP INLET VALVE	A	FUEL TNKNG
		4- OPEN RETURN VALVE	A	FUEL TNKNG
		5- CLOSE PUMP FE RESTRICTED FLOW VALVE	A	FUEL TNKNG
		6- OPEN FUEL PRE-VALVES	26	FUEL TNKNG
0149	*	DRAIN MISSILE FUEL TANK		
		FUEL LEAK-THRUST CHAMBER-		
		1- MONITOR FUEL TANK PRESSURE		PRESS
		2- OPEN STORAGE TANK VENT VALVE		FUEL TNKNG
		3- OPEN FILL & DRAIN VALVE	A	FUEL TNKNG
		4- REPORT TANK LEVEL AT 20 IN INTERVALS		INST
		5- WHEN TANK LEVEL REACHES STA 1160/		INST
		TANK FILLED & OFF		FUEL TNKNG
015[illegible]	*	OBSERVERS REPORT CONDITION OF MISSILE & STAND		
0151	*	PA CALLOUT / AREA IN CONDITION [illegible]SER		
0152	*	STAND ENGINEER & FIRE LIGHT TO AREA/REPORT GENERAL MISSILE & STAND CONDITION		
0153	*	FIRE AND & I ST [illegible] TO T [illegible] ROOM WITH BREATHING APPARATUS/CHECK & REPORT		
015[illegible]	*	TEST STAND SAFETY CREW TO AREA / 4 MECHANICS & INSPECTOR		

CONFIDENTIAL

0155 * INSTALL FLR & DEFL SAFETY KIT & COVERS/REPRUT
NOTE -IF RUN IS ABORTED, REMOVE ALL IGNITERS
BEFORE DRAINING PROPELLANTS FROM ENGINES

[illegible]	.155	*	SWITCH COMMUNICATIONS TO NORMAL POWER	BLKHS &SHT
[illegible]	.157	*	SECURE EMERGENCY DIESEL GENERATOR & REPORT	
[illegible]	.150	*	DEPRESSURIZE MISSILE TANKS TO SEQUENCE 1-REPORT	
			1- DEPRESS PRESSURIZATION RESTEP SW	PRESS
			2- MONITOR TANK PRESSURES	PRESS
			A-LO2 2 PSIG	2 PSIG
			B-FUEL 5.5 PSIG	5.5 PSIG
[illegible]	0158	*	PUT MISSILE INTO STRETCH	PRESS
	016[illegible]	*	BLEED OFF PRESSURE FROM CO2 SYSTEM & REPORT	
			1- CLOSE CO2 STORAGE UNIT DISCHARGE VLV V-1	CO2 STORGE
			2- OPEN CO2 HOSE REEL NOZZLE TILL PRESS DROPS/SECURE HOSE	TEST STAND
	0[illegible]1		[illegible] TOTALIZER INDICATES ZERO FLOW OF HELIUM FLOW IS INDICATED	FUEL PAD PRESS
			DELETE-	
			1- CLOSE BOOSTER FUEL PRE-VALVE	FUEL TNKNG
			2- CLOSE FILL & DRAIN VALVE	FUEL TNKNG
			3- CLOSE STORAGE TANK VENT VLV	FUEL TNKNG
			4- OPEN STORAGE TANK PRESS VLV/ [illegible] 5 PSIG	FUEL TNKNG

CONFIDENTIAL

CONFIDENTIAL

CONFIDENTIAL

			TANK PRESS TO 3 PSIG/CLOSE	
			5- TEST POSITION KEY OFF	
			6- PANEL OPERATIONAL POWER SW OFF	FUEL TNKNG
	0164	*	SECURE VIBROTRON MONITORING EQUIP AT 3 REPORT	FUEL TNKNG
			1- PRINTER PO ER SW OFF	INST
			2- FUEL VIBRATRON READOUT POWER SW OFF	INST
			3- LO2 VIBRATRON READOUT POWER SW OFF	INST
			4- LO2 & FUEL EPDT METER POWER SWS OFF	INST
			5- TURN OFF LAMBDA POWER SUPPLY	INST
			A-DC POWER SW OFF	
			B-AC POWER SW OFF	
CM.C	0165	*	SET LN2 SYSTEM TO STANDBY	
			1- CLOSE LN2 STORAGE TANK OUTLET VALVE	PRESS PAD
			IDCLN	
			2- L 2 DUMP VLV SW TO CLOSE	PNEUMATIC
			3- OPEN HEAT EXCHANGE LN2 DRAIN VLV	PRESS PAD
			4- L N2 HOSE PURGE SW ON/HEAT EXCHANGER	PRESS PAD
			5- CLOSE LN2 FLUSHING WATER VALVE	TEST STAND
	0164	*	ACTIVATE THRUST SECTION HEATER	
			DELETE1-	
			2- START HEATING UNIT	
			3- HEAT UNIT CONTROL SW ON	
			4- DEPRESS BURNER START SW	
			5- MONITOR OUTLET TEMP TO APPROX 300F	

0165 * PA CALLOUT-STAND IN LOCAL AMBER - TEST AREA IN
CONDITION GREEN/ALL TECHS & TECHS TO TEST AREA

0166 * PERFORM FIRST STAGE SEPARATION TEST
DELETED-

1- CLEAR ALL PERSONNEL FROM STA 55		TEST STAND
2- A/P AC POWER SW ON	G	AUTOPILOT
3- ENGINE CUTOFF LOCKOUT SW ON		A/P PG BAS
4- A/P ARMED/SAFE SW TO ARMED	A	AUTOPILOT
5- NOTIFY TEST STAND THE FIRST STAGE SEPARATION CARTRIDGES WILL FIRE IN APPROX 2 MIN		
6- START AUTOPILOT FLIGHT PROGRAMMER		AUTOPILOT
7- OBSERVERS REPORT ACTIVATION OF SEPARATION SYSTEM		
8- WHEN PROGRAMMER RECYCLED, ANNOUNCE AREA CLEAR		
9- ENGINE CUTOFF LOCKOUT SW OFF		A/P PG BAS
10-ARMED/SAFE SW TO SAFE		AUTOPILOT
11-A/P AC POWER SW OFF		AUTOPILOT
12-ELECTRICALLY DISCONNECT CARTRIDGES		MISSILE
13-REPORT CARTRIDGES NOT FIRED		TEST STAND
14-REMOVE ALL CARTRIDGES		MISSILE

CHG. 0167 * SET FIREX SYSTEM TO FAIL DRY & REPORT

1- SHIFT FCC MANUAL SELECTOR VALVE 323M TO FAIL-DRY	A	VLV PIT #3 FIREX
2- LAUNCHER COOLANT MANUAL SELECTOR VLV		VLV PIT ...

CONFIDENTIAL

CONFIDENTIAL

			0120 TO FAIL-DRY	A	FIREX
			5- LO ER MISSILE DELUGE MANUAL SELECTOR		TS-STA17-R
			VALVE 420 TO FAIL-DRY	A	FIREX
	016		ACTIVATE SERVICE TO ER 3 UTILITY PANEL SDC2		
			1- TURN ON ELEVATOR POWER S -12		SDC BLDG
	0169	*	SECURE MISSILE TERMINAL BOX PURGES & REPORT		
			CAUTION- DO NOT OPEN BOXES TIL PRESS RELIEVED		
			1- CLOSE ELECTRIC L BOX GN2 PURGE		TS-STA3-R
			SUPPLY VALVE 0-73.		
	0170	*	SET UP LO2 TANKING UNIT FOR WARMUP		
			1- CLOSE LO2 STORAGE TANK OUTLET VALVE		LO2 PAD
			1 BLK		
			2- OPEN PUMPING RETURN VLV	A	LO2 CNTRL
			3- OPEN PUMP INLET VLV	A	LO2 CNTRL
	0171	*	SECURE RCC TRANSFER RCC EQUIPMENT & REPORT		
			1- CATHODE FOLLOWER POWER ON OFF		
			2- AUDIO WARNING CH 32 POWER ON OFF		
			3- AUDIO WARNING CH 33 POWER ON OFF		
			4- AUDIO WARNING CH 34 POWER ON OFF		
	0172	*	FIRE EN START HOSE FLUSH INTO FLAME DEFLECTOR		
			DELETE -		
	173	*	ENGINE TEST START BUS ON	A	ENG TEST
			DELETE -		
	017.		AUTOPILOT AC POWER ON	G	AUTOPILOT

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

DELETED-

17[illegible] [illegible]

DELETED-

1- [illegible] 3[illegible] | | C | HYDRAULIC

2- CLOSE [illegible] | | G | HYDRAULIC

[illegible] PURGE P[illegible] | | | PURGE

DELETED-

177 [illegible] FUEL [illegible]

DELETED-

1- BOOSTER LO2 PURGE [illegible] ON

2- [illegible]TAINER LO2 [illegible] FUEL PURGE [illegible] PURGE

3- [illegible] FUEL TA[illegible] PURGE

4- AFTER 20 SEC, OPEN FUEL PREVALVES PRESS

5- [illegible]IN FUEL VALVES [illegible] TO OPEN TILL G FUEL TNKNG

[illegible] SIGN OF FUEL/CLOSE GG ENG TEST

6- FUEL INJECTOR PURGE ON - OFF

7- CLOSE FUEL PREVALVES ENG TEST

8- [illegible]TOP HOSE FLUSH IN FLAME DEFLECTOR FUEL TNKNG

9- BOOSTER LO2 PURGE [illegible] OFF

10-[illegible] LO2 & FUEL PURGE [illegible] OFF PURGE

11-VERNIER LO2 & FUEL PURGE [illegible] PURGE

[illegible]IT 10 SEC/[illegible] OFF PURGE

[illegible] [illegible] HYDRAULIC SYSTEMS & REPORT

1- [illegible] BOOSTER HYDR[illegible] VLV

CONFIDENTIAL

CONFIDENTIAL

	2- STOP BOOSTER GROUND PUMP	
	3- OPEN SUSTAINER BYPASS VLV	HYDRAULIC
	4- STOP SUSTAINER GROUND PUMP	HYDRAULIC
	5- HEATER SWS OFF	HYD CARTS
	6- REFRIGERATION SWS OFF	HYD CARTS
017.	CHECK BOOSTER & SUSTAINER HYD RESERVOIR	MISSILE
	FLUID LEVELS BETWEEN FILL & FULL MARKS ON SIGHT GLASSES	
	1- IF LEVELS ARE LOW, DETERMINE & NOTE CAUSE	
0180	CHECK A/P SAFETY SW SAFETIED	INST
0181 *	SECURE FLIGHT CONTROL SYSTEM & REPORT	
	1- TEST PROGRAMMER PANEL POWER SW OFF	A/P TST PG
	2- AUTOPILOT AC POWER SW OFF	AUTOPILOT
	3- AUTOPILOT DC POWER SW OFF	AUTOPILOT
	4- PANEL POWER SW OFF	AUTOPILOT
0182 *	OPEN POD 1 DOORS	MISSILE
	1- CLOSE P. U. PURGE VALVE	POD 1
0183 *	SECURE GAS CONTROL HELIUM SYSTEM	
	1- SHUT OFF FUEL START TANK REG	MISSILE
	2- GAS CONTROL HE VALVE SW OFF	PNEUMATIC
	3- OPEN H.P. VENT VALVE	B HYD CART
0184 *	CHECK NOSE CONE SHIELD LOCK STABILIZER FOR	NOSE CONE
	3 1/4 -0- 3 1/4 INCHES PLAY & REPORT	
0185 *	PA CALLOUT - STAND BY IN CONDITION GREEN	
	AREA LEFT IN ORDER-	

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

C167	J1A6	A SECURE ENGINE SYSTEM	
		1- CHECK BOOSTER FUEL PREVALVE SW TO CLOSED	FUEL TANKING
		2- ENG TEST SELECTOR SW OFF	ENG TEST
		3- ENG TEST/ARM SW OFF	ENG CNTRL
		4- ENG CNTRL POWER SW OFF	ENG CNTRL
		5- AREA CLEAR SW OFF	LCHR BOX 2
		6- ENGINE AC ENGINEERING OFF-	LCHR BOX 2
		7- ENGINE DC TRACKER OFF	LCHR BOX 2
C167	J1B7	TURN OFF THE FOLLOWING CONSOLE PANEL POWER SWS	
		1- FUEL TANKING	
		A-PJ PUMP SW OFF	
		2- LOX LEVEL INDICATOR	
		3- FI-EX	
C167	[illegible]	SECURE MISSILE PWR	
		1- MISSILE AC PWR SW OFF	MISSLE PWR
		2- MISSILE AC GENERATOR SW OFF	FACLTY PWR

APPENDIX B

OBSERVERS VERBATIM
TESTIMONY

RUN S2-212-B4-01

VISUAL OBSERVER: K. E. Newton, Chief Test Conductor

LOCATION: Right Blockhouse Periscope

LO_2 tanking, tank pressurization, vents and Vernier ignition appeared normal. Booster and Sustainer ignition appeared short. Observed a fire and smoke coming out of thrust section and enveloped the Bl area. Firex and CO_2 came on and fire was immediately extinguished.

S/ K. E. Newton
K. E. Newton

~~CONFIDENTIAL~~

VISUAL OBSERVER: R. R. MacDougal, S2 Stand Engineer

LOCATION: Middile Blockhouse Periscope

LO_2 tanking, tank pressurization, vents and ignition appeared normal. First noticed puff of fire and smoke apparently concentrated around B1. The viewing angle could cause smoke around the Sustainer to appear concentrated around B1.

S/ R. R. MacDougal
R. R. MacDougal

VISUAL OBSERVER: E. R. McFadden, Test Conductor

LOCATION: Left Blockhouse Periscope

During ignition stage attention was directed to Sustainer Tachometer speed recorder. An abrupt rise and drop of recorder was noted during ignition. Started for periscope; when fire warning came from tank observer, immediately called for cutoff, CO_2 and firex.

S/ E. R. McFadden
E. R. McFadden

~~CONFIDENTIAL~~

VISUAL OBSERVER: R. C. Lynch, Asst. Test Conductor

LOCATION: Blockhouse TV

Was watching test conductor's console and two channels of closed loop TV. Vernier ignition appeared reasonably normal as did early ignition stage on main chambers. Mainstage never developed either on TV or on test conductor's console. My first indication of a malfunction was at the end of ignition stage, or where ignition stage should have ended. Hear no explosion but suddenly saw what appeared to be burning fuel falling from the thrust section between the Sustainer engine and B1 on the Quad I side of the missile. Light indications on test conductor's consoles where improper at this time, but I cannot recall to what extent they were wrong.

Depressed Vernier cutoff button at first indication of the malfunction and commenced the activation of fire fighting system.

S/ R. C. Lynch
R. C. Lynch

VISUAL OBSERVER: C. H. Oliver, Test Engineer

LOCATION: North Tank Observer

V2 ignition appeared normal. Booster and Sustainer ignition start appeared normal. Almost immediately after ignition start observed Vernier cutoff. Ignition stage suddenly appeared as a fire with flames billowing out around the thrust section. Fire seemed concentrated under B1 and Sustainer engine. Called for cutoff. Firex and CO_2 came on and fire was promptly extinguished. CO_2 turned off. Shortly afterwards the fire flared up again. CO_2 was turned on and fire again extinguished. CO_2 was turned off and firex was left on. No further indication of fire. Detanking of LO_2 appeared normal. Fuel leak during attempt to detank fuel could not be seen from north tank due to firex water, LN_2 flush water and heavy vapor.

S/ C. H. Oliver
C. H. Oliver

VISUAL OBSERVER: Frank DiPiazza, Test Engineer

LOCATION: South Tank Observer

First sited a fuel rich abnormal Vernier engine ignition and then the appearance of mainstage and an immediate cutoff. Sound of cutoff was present. At that time, I noticed a spreading fire in the area of Vernier engine V1, and immediately I reported fire.

S/ F. DiPiazza
F. DiPiazza

VISUAL OBSERVER: Dane Allard, Photographer

LOCATION: Photo Tank Observer

As the main engines ignited I noticed a burst of flame and smoke which seemed to be concentrated under the Sustainer and B1 engines. The flames and smoke engulfed the lower section of the missile. After the fire was extinguished a second flare-up occurred which was also promptly extinguished.

S/ Dane Allard
Dane Allard

APPENDIX C

SUMMARY OF DATA PRESENTATION
BY MEASUREMENT NUMBER

RUN S2-212-B4-01

NOTE: Appendix C lists all measurements recorded during Run 212 and describes the method employed in analyzing each record. The following abbreviations are used in column headings.

TAB: Tabulated
GRA: Graphical presentation
NOT SIG: Not significant
NOT REV: Not relavent

APPENDIX -C-
SUMMARY OF DATA PRESENTATION
BY MEASUREMENT NUMBER
RUN S2-212-B4-01 18 JUNE 58

MEAS #	DESCRIPTION	REPORT TAB	REPORT GRA	NOT SIG	NOT REV	COMMENT
A1264D	MSL TK MOVEMENT X AX	X				
A1266D	MSL TK MOVEMENT Y AX	X				
A1386T	ENG COMP AFT AMB Q1		X			
A1387T	ENG COMP AFT AMB Q2		X			
A1388T	ENG COMP AFT AMB Q3		X			
A1389T	ENG COMP AFT AMB Q4		X			
E1006V	INVERTER PHASE A			X		114 V
E1023V	EXT AC PHASE A			X		104.64 V
E1027V	PROP CONTROL INPUT	X				
E1028V	MSL SYSTEMS INPUT	X				
F1001P	LO2 TANK HELIUM	X				
F1003P	FUEL TANK HELIUM	X				
F1005P	B TK HE BTL DISCH	X				
F1011P	LO2 PRES REG DISCH	X				

~~CONFIDENTIAL~~

F1034P	FUEL PRES ORFC DP	X				
F1065P	LO2 TK HE LN @ ORFC	X				
F1066P	GO2 BO LN @ ELBOW			X		
F1067P	GO2 BO ELBOW TAP DP			X		
F1114P	LO2 PRES REG INLET	X				
F1121P	B CTL HE BRL DISCH	X				
F1124P	S TK HE BTL DISCH	X				
F1125P	B CTL PNEU REG	X				
F1142P	S CTL PNEU REG OUT	X				
F1145P	S CTL HE BTL DISCH	X				
F1147P	LO2 PRES ORFC DP	X				
F1212P	FUEL PRES ORFC IN			X		INVALID DATA
F1017T	FUEL PRES ORFC IN			X		
F1064T	GO2 BO LN @ ELBOW			X		
F1115T	LO2 PRES REG IN	X				
F1122T	BCTL HE BTL DISCH	X				
F1123T	S TK HE BTL DISCH		X			
F1130T	B CTL HEAT XGR OUT	X				
F1144T	S CTL HE BTL DISCH		X			
F1146T	LO2 PRES ORFC IN			X		
F1219T	AIRBORNE REGS SUP	X				
H1003P	MSL HYD PUMP DISCH			X		
H1033P	B1 HYD ACCUMULATOR			X		
H1052P	S HYD ACCUMULATOR	X				

H1140P	V HYD PUMP DISCH	X		
H1001T	MSL HYD PUMP DISCH		X	
H1131T	S HYD PUMP DISCH	X		
H1141T	V HYD OIL SUPPLY		X	
L1161P	FL DEFR WATER MAN		X	
L1155S	TOT AUX STRUT 1A		X	
L1156S	TOT AUX STRUT 1B		X	
L1157S	TOT AUX STRUT 2A		X	
L1158S	TOT AUX STRUT 2B		X	
L1257T	FLAME DEFLECTOR		X	
L1259T	FLAME DEFLECTOR		X	
L1263T	FLAME DEFLECTOR		X	
N1011F	WT & THST SYS-THRUST		SEE ST219F	
P1083B	B2 PUMP SPEED		X	
P1084B	B1 PUMP SPEED		X	
P1349B	S PUMP SPEED		X	
P1528D	S MAIN FUEL VALVE		X	
P1529D	S MAIN LO2 VALVE	X		
P1439O	S NAA RCC ACCEL		X	

P14520	B1 NAA RCC ACCEL			X	
P14530	B2 NAA RCC ACCEL				X
P1001P	B1 LO2 PUMP IN /BROWN/	X			
P1001P	B1 LO2 PUMP IN /CEC/				X
P1003P	B2 LO2 PUMP INLET /BROWN/	X			
P1003P	B2 LO2 PUMP INLET /CEC/				X
P1004P	B2 FUEL PUMP INLET/BROWN/	X			
P1004P	B2 FUEL PUMP INLET /CEC/				X
P1006P	S THRUST CHAMBER /BROWN/	X			
P1006P	S THRUST CHAMBER			X	
P1010P	B1 LUB OIL MAN	X			
P1011P	B2 LUB OIL MAN	X			
P1026P	B LO2 REG REFERENCE	X			
P1027P	VERNIER FUEL TANK	X			
P1028P	V1 THRUST CHAMBER	X	X		
P1029P	V2 THRUST CHAMBER	X	X		
P1030P	VERNIER LO2 TANK	X			
P1047P	V1 LO2 INLET /BROWN/	X	X		
P1047P	V1 LO2 INLET /CEC/				X
P1048P	V2 LO2 INLET /BROWN/	X	X		
P1048P	V2 LO2 INLET /CEC/				X
P1049P	V1 FUEL INLET /BROWN/	X	X		
P1049P	V1 FUEL INLET /CEC/				X
P1050P	V2 FUEL INLET /BROWN/	X	X		
P1050P	V2 FUEL INLET /CEC/				X

CONFIDENTIAL

P1055P	S FUEL PUMP INLET	X		
P1056P	S LO2 PUMP INLET /BROWN/	X		
P1056P	S LO2 PUMP INLET /CEC/			X
P1059P	B2 THRUST CHAMBER /BROWN/	X		
P1059P	B2 THRUST CHAMBER /CEC/			X
P1060P	B1 THRUST CHAMBER /BROWN/	X		
P1060P	B1 THRUST CHAMBER /CEC/			X
P1075P	G FUEL START TANK	X		
P1091P	B1 LO2 INJ MANIFOLD		X	
P1092P	B2 LO2 INJ MANIFOLD		X	
P1093P	B1 FUEL INJ MANIFOLD		X	
P1094P	B2 FUEL INJ MANIFOLD		X	
P1100P	B GG COMBUSTION CHM	X		
P1177P	B LO2 START TANK REG	X		
P1178P	G FUEL START TANK REG		X	
P1181P	LO2 DEL MSL FILL VLV			X
P1182P	FUEL DEL AT FILL VLV			X
P1235P	VERN LO2 TK REG OUT	X		
P1236P	VERN FUEL TK REG OUT	X		
P1280P	SGG FUL VLV INLET	X		
P1330P	S FUL PUMP DISCH	X		
P1332P	S LO2 PUMP DISCH	X		
P1337P	SGG LO2 INJ MAN	X		
P1339P	S GAS GEN DISCH	X		
P1341P	S LUB PUMP GEAR	X		
P1344P	S LO2 REG REFERENCE	X		

P1350P	S FUEL INJ MANIFOLD	X			
P1351P	S LO2 INJ MANIFOLD	X			
P1489P	B GAS GEN LO2 VLV IN	X			
P1007R	SUSTAINER FUEL FLOW		X		
P1008R	SUSTAINER LO2 FLOW		X		
P1037R	B GAS GEN LO2 FLOW		X		
P1042R	VERNIERS LO2 FLOW		X		
P1043R	VERNIERS FUEL FLOW		X		
P1051R	B GAS GEN & IGN FUEL		X		
P1333R	S GAS GEN LO2 FLOW		X		
P1334R	S GAS GEN FUEL FLOW		X		
P1014T	ENGINE COMP AMBIENT		X		
P1017T	B2 TURBINE IN			X	75-100 DEG F
P1018T	B1 TURBINE IN			X	80-90 DEG F
P1020T	B1 LO2 PUMP INLET		X		
P1021T	LO2AT BREAKAWAY VLV		X		
P1126T	B1 LO2 PUMP OTBD BRG			X	138-145 DEG F
P1127T	B2 LO2 PUMP OTBD BRG			X	157 DEG F
P1209T	B2 TURBINE BEARING			X	74 DEG F
P1213T	B1 TURBINE BEARING			X	MINUS 30 DEG F
P1323T	S TURBINE BEARING		X		
P1324T	S PUMP BEARINGS-LO2		X		
P1336T	S GAS GEN DISCH		X		
P1437W	S RCC BINARY COUNTER			X	

CONFIDENTIAL

P1454W	B1 RCC BINARY COUNT	X	
P1455W	B2 RCC BINARY COUNT		X
P1067X	B2 LO2 VLV CLSD MSW	X	
P1068X	B1 LO2 VLV CLSD MSW	X	
P1069X	B2 FUEL VLV CLSD MSW	X	
P1070X	B1 FUEL VLV CLSD MSW	X	
P1071X	B GG VLV CLSD MSW	X	
P1072X	BOOSTER CUTOFF RELAY	X	
P1078X	VERN LO2 TK PRES SOL	X	
P1079X	VERN FUL TK PRES SOL	X	
P1096X	VERN TKS PRES RELAY	X	
P1135X	PROP ST PRES RELAY	X	
P1136X	B IGN DETR DELAY COF	X	
P1137X	ETP PREP COMPLETE LT	X	
P1139X	B LO2 V OPEN CTL SOL	X	
P1142X	TCC IGN COMPLETE LT	X	
P1143X	B GAS GEN IGN LINK	X	
P1145X	BGG VLV OPEN CTL SOL	X	
P1146X	BGG VLV CLOS CTL SOL	X	
P1147X	BGG VLV OPEN MSW	X	
P1148X	B FUL V OPEN CTL SOL	X	
P1149X	B1 VLV CLOS CTL	X	
P1150X	B FUL V CLOS CTL SOL	X	
P1154X	TCC MAIN ENG COF SW	X	
P1155X	OBSERVER CUTOFF	X	

P1156X	B1 TBN OVRSPEED TRIP	X
P1157X	B2 TBN OVRSPEED TRIP	X
P1158X	PREP INCOMPLETE COF	X
P1164X	TCC VERN ENG COF SW	X
P1165X	VERN ENG LOKIN RELAY	X
P1166X	FUEL INJ PURGE SOL	X
P1167X	VM PROP OPEN CTL SOL	X
P1169X	B2 LO2 VLV OPEN MSW	X
P1170X	B1 LO2 VLV OPEN MSW	X
P1186X	TCC FUEL S T FULL LT	X
P1192X	B1 ROUGH COMB COF	X
P1193X	B2 ROUGH COMB COF	X
P1194X	B1 FUEL VLV OPEN MSW	X
P1195X	B2 FUEL VLV OPEN MSW	X
P1196X	S LO2 V OPEN CTL SOL	X
P1197X	S LO2 V VLOS CTL SOL	X
P1198X	S LO2 VLV OPEN MSW	X
P1199X	S LO2 VLV CLOSED MSW	X
P1200X	S FUL V OPEN CTL SOL	X
P1201X	S FUL V CLOS CTL SOL	X
P1202X	S FUEL VLV OPEN MSW	X
P1203X	S FUEL VLV CLSD MSW	X
P1219X	#1 OBSERVER CUTOFF	X
P1220X	#2 OBSERVER CUTOFF	X
P1221X	#3 OBSERVER CUTOFF	X
P1222X	#4 OBSERVER CUTOFF	X

CONFIDENTIAL

CONFIDENTIAL

P1223X	#5 OBSERVER CUTOFF	X
P1224X	#6 OBSERVER CUTOFF	X
P1225X	#7 OBSERVER CUTOFF	X
P1226X	#8 OBSERVER CUTOFF	X
P1227X	#9 OBSERVER CUTOFF	X
P1228X	#10 OBSERVER CUTOFF	X
P1229X	#11 OBSERVER CUTOFF	X
P1230X	#12 OBSERVER CUTOFF	X
P1299X	B IGN DETR DELAY - PU	X
P1335X	S GG VALVE CLSD MSW	X
P1347X	S CUTOFF SIGNAL	X
P1427X	VERN LO2 VENT SW	X
P1429X	TCC RELEASE SWITCH	X
P1438X	ROUGH COMB COF S	X
P1441X	B IGN STAGE TIMER-DO	X
P1443X	LO2 PRE VALVE OPEN	X
P1444X	LO2 PRE VALVE CLOSED	X
P1445X	FUEL PRE VALVE OPEN	X
P1446X	FUEL PRE VALVE CLSD	X
P1499X	S GG VLV OPEN MSW	X
P1503X	B FUEL S T VENT CTL	X
P1510X	TCC VERN CMPLT LITE	X
P1512X	B2 LO2 V CLOS CTL	X
P1515X	VERN STRT DY COF	X
P1516X	VERN SQUIBS FIRING	X
P1519X	VERN STRT DY COF TMR	X

P1561X	B LO2 REG REF VENT	X	
P1566X	DC GRND PWR FAIL COF	X	
P1568X	STRT TKS PRESS TIMER	X	
P1575X	PRE START READY	X	
P1580X	S FUEL PRE VLV CLSD	X	
P1581X	S FUEL PRE VLV OPEN	X	
P1582X	S LO2 REG VENT V CTL	X	
P1583X	S FUEL VLV LOKUP CTL	X	
P1586X	S IGN FUEL V OPEN CTL	X	
P1587X	S GG VLV OPN CTL	X	
P1588X	S TBN OVRSP TRIP	X	
P1591X	S HYD PRES SW	X	
P1592X	B ENG CUTOFF	X	
P1593X	S ENG CUTOFF	X	
P1594X	TCC SUSTAINER COF SW	X	
P1595X	SGG VLV CLSG SOL	X	
P1596X	HOLDON RELEASE REL	X	
P1598X	V ENG CUTOFF	X	
S1074C	B1 PITCH SA OUT		X
S1075C	B2 PITCH SA OUT		X
S1076C	V2 ROLL SA OUT		X
S1077C	V1 ROLL SA OUT		X
S1078C	B1 YAW SA OUT		X
S1079C	B2 YAW SA OUT		X
S1214C	S PITCH SA OUT		X

CONFIDENTIAL

CONFIDENTIAL

S1215C	S YAW SA OUT		X	
S1220C	V1 YAW SA OUT		X	
S1221C	V2 YAW SA OUT		X	
S1061D	ROLL DISPL GYRO SIG		X	
S1062D	PITCH DISPL GYRO SIG		X	
S1063D	YAW DISPL GYRO SIG		X	
S1263T	GYRO CAN TEMP		X	97 DEG F
S1048V	PROG PITCH SIG		X	
S1049V	PROG ROLL SIG		X	
S1107V	B1 PCH ACTR FEEDBAK	X		
S1108V	B2 PCH ACTR FEEDBAK		X	
S1113V	V1 YAW ACTR FEEDBAK		X	
S1114V	V2 YAW ACTR FEEDBAK		X	
S1118V	V2 ROL ACTR FEEDBAK		X	
S1119V	V1 ROL ACTR FEEDBAK		X	
S1121V	GYRO TEST SIGNAL	X		
S1128V	B1 YAW ACTR FEEDBAK		X	
S1129V	B2 YAW ACTR FEEDBAK		X	
S1216V	S PCH ACTR FEEDBAK	X		
S1217V	S YAW ACTR FEEDBAK		X	
S1267V	PCH SERVO TEST SIG		X	
S1268V	YAW SERVO TEST SIG		X	
S1235X	PROGRAM RUN TIME	X		

S1236X	BOOSTER COF DISCRETE	X			
S1237X	BOOSTER COF PRGR OTP	X			
S1238X	JETTISON BOOSTER SIG	X			
S1239X	PRES VERN TKS DISC	X			
S1240X	PRES V TKS PRGR OTP	X			
S1241X	SUSTAINER COF DISC	X			
S1242X	SUS CUTOFF PRGR OTP	X			
S1243X	PRE-ARM DISCRETE	X			
S1244X	PRE-ARM PRGR OTP	X			
S1245X	VERNIER COF DISCRETE	X			
S1246X	VERNIER COF PRGR OTP	X			
S1247X	EJECT NOSECONE UMBIL	X			
S1248X	RELEASE NOSECONE	X			
S1249X	FIRE RETRO-ROCKETS	X			
ST219F	WT & THS SYS TANKING		X		
ST206P	S LUB PUMP BRG			X	
ST001R	SUS HYD FLOW RATE			X	
ST160T	S ENG CTL MAN		X		
ST161T	B ENG CTL MAN		X		
ST162T	V LO2 TK PRES SOL		X		
ST163T	V LO2 TK PRES VLV			X	MINUS 67 DEG F
ST164T	B1 HYD ACUM		X		

CONFIDENTIAL

CONFIDENTIAL

ST165T	S HYD ACUM	X			
ST166T	S HYD RES	X			
ST168T	LO2 ST TK PRES SOL	X			
ST169T	B1 LO2 VLV CLOS CTL	X			
ST170T	B2 LO2 VLV CLOS CTL	X			
ST183T	B2 THS CHM Y AX INPD EXT		X		66-85 DEG F
ST184T	B1 THS CHM Y AX INBD EXT		X		75-101 DEG F
ST185T	B2 THS CHM Y ¤45 DEG EXT	X			
ST186T	B1 THS CHM Y ¤45 DEG EXT		X		75-113 DEG F
ST209T	FIRE DETR SKIRT SECT	X			
ST214T	VIBRATRON CASE TEMP	X			
ST007V	ENG GND PWR BUS			X	
ST152V	A/P 400 CY REF PH A			X	
ST215X	VIBRATRON PRINT READOUT	X			
U1107C	PU SV AMP OUT		X		
U1021P	LO2 TK HD VIBROTRON			X	
U1022P	FUEL TK HD VIBROTRON			X	
U1091V	ERROR RATIO DEMOD OP		X		
U1105V	PU SV COMMAND SIG		X		

APPENDIX D

DETAILED CHRONOLOGICAL HISTORY
OF SIGNIFICANT DATA

RUN S2-212-B4-01

APPENDIX -D-
DETAILED CHRONOLOGICAL HISTORY
OF SIGNIFICANT DATA
S2-212-64-01 18 JUNE 58

TIME	REC	MEAS	DESCRIPTION	EVENT
-467.13	117-2	P1336T	S GAS GEN DISCH	DEC FROM 117 DEG F TO PEG NEG
-299.83	119-2	F1003P	FUEL TANK HELIUM	INC FROM SEG II TO III /55.3 PSIG/
-214.13	208-2	P1337P	SGG LO2 INJ MAN	INC FROM 1.26 PSIG TO 16.70 PSIG
-149.13	221-1	E1027V	PROP CONTROL INPUT	INC FROM 27.3 TO 33.6 VOLTS FOR 13 SEC
-149.13	221-1	E1027V	PROP CONTROL INPUT	ON INT SWOVER ATTEMPT
-149.13	221-2	E1028V	MSL SYSTEMS INPUT	INC FROM 27.7 TO 34V ON INT SWOVER ATMP
-149.13	221-2	E1028V	MSL SYSTEMS INPUT	BACK TO EXT AFTER 13 SEC
-129.13	221-1	E1027V	PROP CONTROL INPUT	INC FOR 7 SEC ON 2ND INT SWOVER ATTEMPT
-129.13	221-2	E1028V	MSL SYSTEM INPUT	2ND SWOVER ATTEMPT 34V FOR 7 SEC
-105.63	221-1	E1027V	PROP CONTROL INPUT	INC FOR 16 SEC ON 3RD INT SWOVER
-105.63	221-1	E1027V	PROP CONTROL INPUT	ATTEMPT
-105.63	221-2	E1028V	MSL SYSTEMS INPUT	3RD SWOVER ATTEMPT 34V FOR 16 SEC
-38.13	122-1	P1003P	B2 LO2 PUMP IN	OSCILLATES @ 8 CPS FOR 3.5 SEC
-38.03	123-1	P1001P	B1 LO2 PUMP IN	OSCILLATES FOR 1.5 SEC @ 4 CPS
-37.93	123-3	P1056P	S LO2 PUMP INLET	OSCILLATES FOR 1 SEC @ 8 CPS
-31.36	121-3	F1011P	LO2 PRES REG DISCH	INC FROM 25 TO 26.5 PSIG
-30.89	119-2	F1003P	FUEL TANK HELIUM	INC FROM 55.3 TO 57.8 PSIG IN 27.7 SEC
-30.43	123-3	P1056P	S LO2 PUMP INLET	OSCILLATES FOR .6 SEC @ 11 CPS
-25.00	121-2	F1001P	LO2 TANK HELIUM	PRE START STEADY 26.5 PSIG

~~CONFIDENTIAL~~

-25.00	217-2	F1005P	B TK HE BTL DISCH	STEADY 3130 PSIG
-25.00	217-1	F1121P	B CTL HE BTL DISCH	STEADY 3200 PSIG
-25.00	CEC	F1017T	FUEL PRES ORFC IN	STEADY 60 DEG F
-25.00	222-1	F1122T	B CTL HE BTL DISCH	STEADY MINUS 175 DEG F
-17.15	123-2	P1021T	LO2 AT BREAKWAY VLV	DEC FROM MINUS 285 TO MINUS 291 DEF F
-14.24	29	P1161X	TCC VERN ENG STR SW	ACTIVATE
-14.23	27	P1078X	VERN LO2 TK PRES SOL	ACTIVATE
-14.23	26	P1079X	VERN FUL TK PRES SOL	ACTIVATE
-14.23	25	P1096X	VERN TKS PRES RELAY	ACTIVATE
-14.23	23	P1135X	PROP S T PRES RELAY	ACTIVATE
-14.23	24	P1427X	VERN LO2 VENT CONT	DEACTIVATE
-14.22	113-3	P1177P	B LO2 START TANK REG	TRANSIENT 508 TO 498 TO 514 PSIG
-14.21	109-1	P1030P	VERNIER LO2 TANK	INC FROM AMB /MINUS 14/ TO 515 PSIG
-14.18	110-2	P1236P	VERN FUEL TANK REG OUT	DEC 533 PSIG TO 524 PSIG
-14.17	110-1	P1027P	VERNIER FUEL TANK	INC FROM AMB /MINUS 6 PSIG/ TO 527 PSIG
-14.17	109-2	P1235P	VERN LO2 TK REG OUT	TRANSIENT 523 TO 479 TO 529 PSIG
-14.13	209-3	P1049P	V1 FUEL INLET	INC FROM AMB /62 PSIG/ TO 524 PSIG
-14.13	210-1	P1050P	V2 FUEL INLET	INC FROM AMB/67 PSIG/TO 518 PSIG
-14.13	110-3	P1075P	G FUEL START TANK	TANK PRESSURIZES
-14.11	109-3	P1489P	B GAS GEN LO2 VLV IN	INC FROM AMB/48 PSIG/ TO 495 PSIG
-13.99	209-2	P1048P	V2 LO2 INLET	INC FROM AMB /32 PSIG/ TO 519 PSIG
-13.96	209-1	P1047P	V1 LO2 INLET	INC FROM AMB /32 PSIG/ TO 520 PSIG
-13.93	208-2	P1337P	SGG LO2 INJ MAN	INC FROM 16.70 PSIG TO 35.20 PSIG
-13.84	208-3	P1280P	SGG FUEL VLV INLET	INC FROM AMB /167 PSIG/ TO 956 PSIG
-12.18	30	P1568X	STRT TKS PRESS TIMER	ACTIVATE
.00	28	P1516X	VERN SQUIBS FIRING	ACTIVATE

CONFIDENTIAL

.59	113-1	F1142P	S CTL PNEU REG OUT	STEADY AT 737 PSIG
.63	31	P1165X	VERN ENG LOKIN RELAY	ACTIVATE
.64	32	P1167X	VERN PV OPEN CTL	ACTIVATE
.65	131	S1240X	PRES V TKS PRGR OTP	ACTIVATE
.71	209-2	P1048P	V2 LO2 INLET	TRANSIENT - 519 TO 366 TO 502 PSIG
.71	210-1	P1050P	V2 FUEL INLET	TRANSIENT 518 TO 271 TO 450 PSIG
.76	209-1	P1047P	V1 LO2 INLET	BEGAN OSCILLATION FOR .6 SEC
.79	109-1	P1030P	VERNIER LO2 TANK	DEC FROM 518 PSIG TO 510 PSIG
.83	109-2	P1235P	VERN LO2 TK REG OUT	TRANSIENT 525 TO 518 TO 528 PSIG
1.03	219-1	P1028P	V1 THRUST CHAMBER	INC FROM AMB /8 PSIG/ TO 188 PSIG
1.03	219-2	P1029P	V2 THRUST CHAMBER	INC FROM AMB /1 PSIG/ TO 213 PSIG
1.06	112-2	P1004P	B2 FUEL PUMP INLET	DEC FROM MINUS .8 PSIG TO PEG NEG
1.27	219-2	P1029P	V2 THRUST CHAMBER	OSCILLATES 4 CPS FOR .6 SEC
1.47	CEC-	F1034P	FUEL PRES ORFC DP	INC FROM 16.1 TO 17.0 PSIG
1.47	CEC-	F1147P	LO2 PRES ORFC DP	INC FROM 53.6 TO 54.4 PSIG
1.47	218-3	P1341P	S LUBE PUMP GEAR	INC FROM AMB /17 PSIG/ TO 32.2 PSIG
1.56	39	P1510X	TCC VERN COMPLETE LT	ACTIVATE
1.57	36	P1166X	B&S FUEL INJ PRG SOL	ACTIVATE
1.67	CEC-	F1065P	LO2 TK HE LN @ ORFC	INC FROM 25 TO 28 PSIG
1.73	209-3	P1049P	V1 FUEL INLET	TRANSIENT 524 TO 290 TO 453 PSIG
1.81	113	P1149X	B1 LO2 V CLOS CTL	ACTIVATE
1.81	112	P1512X	B2 LO2 V CLOS CTL	ACTIVATE
1.82	45	P1139X	B LO2 V OPEN CTL SOL	ACTIVATE
1.82	67	P1196X	SUSTAINER HSV SOL B	ACTIVATE
1.82	74	P1197X	SUSTAINER HSV SOL A	ACTIVATE
1.82	66	P1586X	S IGN FUEL V OPEN CTL	ACTIVATE

~~CONFIDENTIAL~~

1.87	108-3	P1529D	S MAIN LO2 VALVE	STARTED OPEN FROM 0 DEG
1.88	123-3	P1056P	S LO2 PUMP INLET	TRANSIENT 46 TO 39 TO 42 PSIG
1.89	221-1	E1027V	PROP CONTROL INPUT	DEC .5 V
1.89	68	P1199X	S LO2 HSV CLOSED MSW	DEACTIVATE
1.91	48	P1067X	B2 LO2 VLV CLSD MSW	DEACTIVATE
1.93	214-1	H1052P	S HYD ACCUMULATOR	DEC FROM 1840 TO 1590 PSIG
1.93	208-3	P1280P	SGG FUEL VLV INLET	TRANSIENT 956 TO 863 TO 941 PSIG
1.94	123-1	P1001P	B1 LO2 PUMP IN	TRANSIENT 51 TO 42 TO 49 PSIG
1.95	110-3	P1075P	G FUEL START TANK	DEC FROM 804 PSIG /IGN FLOW/
1.95	46	P1068X	B1 LO2 VLV CLSD MSW	DEACTIVATE
1.99	216-1	F1145P	S CTL HE BTL DISCH	STEADY AT 3116 PSIG
1.99	122-1	P1003P	B2 LO2 PUMP IN	TRANSIENT 54 TO 42 TO 52 PSIG
2.01	117-3	P1006P	S THRUST CHAMBER	INC FROM AMB
2.01	49	P1169X	B2 LO2 VLV OPEN MSW	ACTIVATE
2.12	110-3	P1075P	G FUEL START TANK	SURGE TO 941 PSIG
2.17	47	P1170X	B1 LO2 VLV OPEN MSW	ACTIVATE
2.22	69	P1198X	S LO2 HSV OPEN MSW	ACTIVATE
2.27	113-1	F1142P	S CTL PNEU REG OUT	TRANS 742 TO 640 TO 825 TO 633 TO 767
2.27	113-1	F1142P	S CTL PNEU REG OUT	TO 743 PSIG
2.30	119-2	P1339P	S GAS GEN DISCH	TRANSIENT 0 TO 87 TO 27 PSIG
2.30	50	P1142X	TCC IGN COMPLETE LT	ACTIVATE
2.31	216-2	F1124P	S TK HE BTL DISCH	STEADY AT 1650 PSIG
2.31	111-1	F1125P	B CTL PNEU REG	STEADY AT 743 PSIG
2.31	CEC	P1351P	S LO2 INJ MANIFOLD	BEGAN OSCILLATION FOR .07 SEC
2.31	109-3	P1489P	B GAS GEN LO2 VLV IN	INC FROM 495 PSIG TO 527 PSIG
2.32	CEC	P1055P	S FUEL PUMP INLET	DEC FROM 64.4 PSIG TO 27 PSIG

2.32	208-2	P1337P	SGG LO2 INJ MAN	TRANSIENT 35.20 TO 130.00 TO 1.26 PSIG
2.33	CEC-	F1034P	FUEL PRES ORFC DP	TRACE BECOMES ERRATIC NOISE
2.33	CEC-	F1065P	LO2 TK HE LN @ ORFC	TRACE BECOMES ERRATIC NOISE
2.33	CEC-	F1147P	LO2 PRES ORFC DP	TRACE BECOMES ERRATIC NOISE
2.33	CEC	F1017T	FUEL PRES ORFC IN	INC FULL SCALE
2.33	109-1	P1030P	VERNIER LO2 TANK	DEC FROM 523 PSIG TO 410 PSIG
2.33	CEC	P1100P	BGG COMBUSTION CHM	TRANSIENT OFF SCALE
2.33	113-3	P1177P	B LO2 START TANK REG	DEC TO 0 PSIG
2.33	208-3	P1280P	SGG FUEL VLV INLET	DROP FROM 941 TO MINUS 24 PSIG
2.33	CEC	P1350P	S FUEL INJ MANIFOLD	TRANSIENT PEG TO PEG
2.33	CEC	P1351P	S LO2 INJ MANIFOLD	TRANSIENT PEG TO PEG
2.33	123-2	P1021T	LO2 AT BREAKWAY VLV	INC TO PEG POS FROM MINUS 287.5 DEG F
2.33	58	P1071X	BGG VLV CLSD MSW	DEACTIVATE
2.33	11	P1137X	ETP PREP COMPLETE LT	DEACTIVATE
2.34	217-2	F1005P	B TK HE BTL DISCH	DROP FROM 2800 TO 0 PSIG
2.34	222-1	F1122T	B CTL HE BTL DISCH	DEC FROM MINUS 175 TO MINUS 193 DEG F
2.34	114-2	F1219T	AIRBORNE REGS SUP	INC FROM 54 DEG F TO PEG POS
2.34	AM-5	P1439O	S NAA RCC ACCEL	TRANSIENT TO APPROX 66.5 G
2.34	AM-8	P1452O	B1 NAA RCC ACCEL	TRANSIENT TO APPROX 51 G
2.34	218-1	P1010P	B1 LUBE OIL MAN	TRANS AMB /5.4 PSIG/ TO MINUS 2.8 TO
2.34	218-1	P1010P	B1 LUBE OIL MAN	AMB
2.34	218-2	P1011P	B2 LUBE OIL MAN	8 PSIG TRANSIENT
2.34	123-3	P1056P	S LO2 PUMP INLET	OSCILLATES FOR 2.6 SEC @ 10 CPS
2.34	208-1	P1330P	S FUEL PUMP DISCH	TRANSIENT 93 TO MINUS 2 TO 104 PSIG
2.34	CEC	P1454W	B1 RCC BINARY COUNT	SPIKE 1.5 MS
2.34	55	P1069X	B2 FUEL VLV CLSD MSW	DEACTIVATE

CONFIDENTIAL

~~CONFIDENTIAL~~

2.34	58	P1071X	BGG VLV CLOSED MSW	ACTIVATE
2.34	11	P1137X	ETP PREP COMPLETE LT	ACTIVATE
2.34	45	P1139X	B LO2 VLV OPEN CTL SOL	DEACTIVATE
2.34	51	P1143X	B GAS GEN IGN LINK	DEACTIVATE
2.34	22	P1503X	GFST VENT CTL	DEACTIVATE
2.34	112	P1512X	B2 LO2 V CLOS CTL	DEACTIVATE
2.34	30	P1568X	STRT TKS PRESS TIMER	DEACTIVATE
2.34	403-1	S1107V	B1 PCH ACTR FEEDBAK	TRANSIENT .5 DEG DN FOR .1 SEC
2.34	403-5	S1216V	S PCH ACTR FEEDBAK	TRANSIENT .25 DEG DN FOR .16 SEC
2.34	405-5	S1217V	S YAW ACTR FEEDBAK	TRANSIENT .5 DEG YAW RT FOR .03 SEC
2.35	121-2	F1001P	LO2 TANK HELIUM	OSCILLATES 23.1 TO 28.7 PSIG
2.35	119-2	F1003P	FUEL TANK HELIUM	OSC 48.2 TO 64.3 PSIG FOR 1.5 SEC
2.35	214-3	F1114P	LO2 PRES REG INLET	DEC FROM 3020 TO 0 PSIG
2.35	119-3	P1332P	S LO2 PUMP DISCH	TRANSIENT 44 TO MINUS 8 TO 67 PSIG
2.35	53	P1070X	B1 FUEL VLV CLSD MSW	DEACTIVATE
2.35	58	P1071X	BGG VLV CLOSED MSW	DEACTIVATE
2.35	113	P1149X	B1 LO2 V CLOS CTL	DEACTIVATE
2.35	49	P1169X	B2 LO2 VLV OPEN MSW	DEACTIVATE
2.35	22	P1503X	GFST VENT CTL	ACTIVATE
2.36	221-1	E1027V	PROP CONTROL INPUT	DEC TO PEG NEG
2.36	111-2	P1026P	B LO2 REG REF	DEC FROM STEADY 536.3 PSIG TO 530.4 PSI
2.36	115-3	P1060P	B1 THRUST CHAMBER	ANB TO 54 PSIG THEN PEGS MINUS
2.36	31	P1165X	VERN ENG LOKIN RELAY	DEACTIVATE
2.36	32	P1167X	VERN PV OPEN CTL	DEACTIVATE
2.36	47	P1170X	B1 LO2 VLV OPEN MSW	DEACTIVATE
2.37	221-2	E1028V	MSL SYSTEMS INPUT	TRANSIENT OF .6 V

CONFIDENTIAL

CONFIDENTIAL

2.37	121-3	F1011P	LO2 PRES REG DISCH	OSCILLATES 15 PSIG
2.37	216-2	F1124P	S TK HE BTL DISCH	TRANS 3100 TO 2530 TO 3330 TO 2475 TO
2.37	216-2	F1124P	S TK HE BTL DISCH	2850 PSIG
2.37	108-3	P1529D	S MAIN LO2 VALVE	REACHED MAX POS 86.77 DEG
2.37	129-1	P1001P	B1 LO2 PUMP IN	OSCILLATES FOR 1.08 SEC @ 4.5 CPS
2.37	110-1	P1027P	VERNIER FUEL TANK	TRANSIENT 527 PSIG TO 507 PSIG
2.37	109-2	P1235P	VERN LO2 TK REG OUT	TRANSIENT 528 TO 429 TO 661 PSIG
2.37	109-3	P1489P	B GAS GEN LO2 VLV IN	DEC TO AMB /48 PSIG/
2.37	3	P1445X	B FUEL PRE VLV OPEN	DEACTIVATE
2.38	115-2	P1059P	B2 THRUST CHAMBER	DEC FROM AMB TO PEG MINUS
2.38	110-2	P1236P	VERN FUEL TANK REG OUT	TRANSIENT 523 TO 427 TO 554 TO 495 PSIG
2.38	220-2	P1014T	ENGINE COMP AMB	TRANSIENT 45.5 TO 42.5 TO 69.0 DEG F
2.38	117-2	P1336T	S GAS GEN DISCH	TRANSIENT PEG NEG TO 390 TO 124 DEG F
2.38	131	S1240X	PRESS V TKS PRGR OTP	DEACTIVATE
2.39	69	P1198X	S LO2 HSV OPEN MSW	DEACTIVATE
2.40	222-1	F1122T	B CTL HE BTL DISCH	INC FROM MINUS 193 DEG F TO PEG POS
2.40	222-3	F1130T	B CTL HEAT XGR OUT	INC FROM 82 DEG F TO PEG POS
2.41	122-1	P1003P	B2 LO2 PUMP IN	OSCILLATES @ 5 CPS FOR 1.2 SEC
2.41	113-2	P1344P	S LO2 REG REF	OSC 165 FROM 789 PSIG FOR 1.7 SEC
2.41	116-3	P1324T	S PUMP BEARINGS-LO2	DEC FROM 182.5 TO 177 DEG F
2.43	217-1	F1121P	B CTL HE BTL DISCH	DEC FROM 3200 TO 0 PSIG
2.44	213-1	H1140P	V HYD PUMP DISCH	600 PSIG DIP TRANSIENT
2.47	115-2	P1059P	B2 THRUST CHAMBER	INC TO 32.80 PSIG
2.48	219-2	P1029P	V2 THRUST CHAMBER	DEC FROM 233 PSIG TO AMB /1 PSIG/
2.48	209-1	P1047P	V1 LO2 INLET	BEGAN OSCILLATION FOR .42 SEC
2.48	209-2	P1048P	V2 LO2 INLET	TRANSIENT ~ 496 TO 585 TO 546 PSIG

~~CONFIDENTIAL~~

2.50	109-1	P1030P	VERNIER LO2 TANK	INC FROM 410 PSIG TO 683 PSIG
2.51	219-1	P1028P	V1 THRUST CHAMBER	DEC FROM 220 PSIG TO AMB /8 PSIG/
2.52	210-1	P1050P	V2 FUEL INLET	TRANSIENT 450 TO 545 TO 514 PSIG
2.53	209-3	P1049P	V1 FUEL INLET	TRANSIENT 453 TO 560 TO 522 PSIG
2.57	122-2	P1004P	B2 FUEL PUMP INLET	TRANSIENT - PEGS POS TO NEG
2.63	220-2	P1014T	ENGINE COMP AMB	TRANSIENT 69.0 TO 64.5 TO 107.0 DEG F
2.65	107-2	A1264D	MSL TK MOVEMENT X AX	STEADY AT .025 INCHES
2.65	107-3	A1266D	MSL TK MOVEMENT Y AX	STEADY MINUS .08 INCHES
2.65	216-1	F1145P	S CTL HE BTL DISCH	TRANSIENT 3079 TO 2391 TO 3288 TO 2257
2.65	216-1	F1145P	S CTL HE BTL DISCH	TO 2655 PSIG
2.65	68	P1199X	S LO2 HSV CLOSED MSW	ACTIVATE
2.68	117-2	P1336T	S GAS GEN DISCH	TRANSIENT 124 TO 213 TO 140 DEG F
2.74	109-1	P1030P	VERNIER LO2 TANK	DEC FROM 683 PSIG TO 410 PSIG
2.77	109-2	P1235P	VERN LO2 TK REG OUT	TRANSIENT 661 TO 455 TO 509 PSIG
2.87	214-1	H1052P	S HYD ACCUMULATOR	INC TO 2210 PSIG
2.87	108-3	P1529D	S MAIN LO2 VALVE	CLOSING - 1.40 DEG
2.96	115-3	P1060P	B1 THRUST CHAMBER	DEC FROM 302.8 PSIG /MAX/ TO PEG MINUS
2.97	CEC	P1100P	BGG COMBUSTION CHM	TRACE RETURNS TO AMB
2.99	117-2	P1336T	S GAS GEN DISCH	DEC FROM 140 DEG F TO PEG NEG
3.01	115-2	P1059P	B2 THRUST CHAMBER	DEC FROM 178.0 PSIG TO PEG MINUS
3.27	107-2	A1264D	MSL TK MOVEMENT X AX	INC TO .125 INCHES
3.27	107-3	A1266D	MSL TK MOVEMENT Y AX	INC TO MINUS .025 INCHES
3.30	217-3	F1115T	LO2 PRES REG IN	INC FROM 80 DEG F TO PEG NEG
3.30	110-2	P1236P	VERN FUEL TANK REG OUT	TRANSIENT 519 TO 426 TO 474 PSIG
3.31	208-1	P1330P	S FUEL PUMP DISCH	TRANSIENT 95 PSIG TO 39 PSIG TO 66 PSIG
3.31	220-2	P1014T	ENGINE COMP AMB	TRANSIENT 107.0 TO 104.3 TO PLUS PEG

CONFIDENTIAL

CONFIDENTIAL

3.37	42	P1299X	B IGN DETR DELAY-PU	ACTIVATE
3.40	117-3	P1006P	S THRUST CHAMBER	MAX DEFL - 6 PSIG
3.42	108-3	P1529D	S MAIN LO2 VALVE	FULL CLOSED
3.79	111-1	F1125P	B CTL PNEU REG	DEC TO .8 PSIG
3.87	221-2	E1028V	MSL SYSTEMS INPUT	STABLE AT 28.3 V
5.08	38	P1077X	VERN COF REL LOCKIN	ACTIVATE
5.08	93	P1566X	DC GND PWR FAIL COF	ACTIVATE
5.09	109-1	P1030P	VERNIER LO2 TANK	DEC FROM 536 PSIG TO AMB /MINUS 14 PSIG
5.09	80	P1347X	S COF RELAY LOCKIN	ACTIVATE
5.09	102	P1582X	S LO2 REG VENT V CTL	ACTIVATE
5.09	107	P1598X	VERNIER ENG COF	ACTIVATE
5.09	133	S1242X	SUS CUTOFF PRGR OTP	ACTIVATE
5.09	137	S1246X	VERNIER COF PRGR OTP	ACTIVATE
5.10	122-2	P1004P	B2 FUEL PUMP INLET	INC FROM PEG NEG TO MINUS 3.5 PSIG
5.10	38	P1077X	VERN COF REL LOCKIN	DEACTIVATE
5.10	93	P1566X	DC GRND PWR FAIL COF	DEACTIVATE
5.10	102	P1582X	S LO2 REG VENT V CTL	DEACTIVATE
5.10	107	P1598X	VERNIER ENG COF	DEACTIVATE
5.10	128	S1237X	BOOSTER COF PRGR OTP	ACTIVATE
5.11	110-1	P1027P	VERNIER FUEL TANK	DEC FROM 475 TO AMB /MINUS 6 PSIG/
5.11	27	P1078X	VERN LO2 TK PRES SOL	DEACTIVATE
5.11	26	P1079X	VERN FUL TK PRES SOL	DEACTIVATE
5.11	23	P1135X	PROP S T PRES RELAY	DEACTIVATE
5.11	11	P1137X	ETP PREP COMPLETE LT	DEACTIVATE
5.11	50	P1142X	TCC IGN COMPLETE LT	DEACTIVATE
5.11	29	P1161X	TCC VERN ENG STR SW	DEACTIVATE

~~CONFIDENTIAL~~

5.11	36	P1166X	B6S FUEL INJ PRG SOL	DEACTIVATE
5.11	67	P1196X	SUSTAINER HSV SOL B	DEACTIVATE
5.11	74	P1197X	SUSTAINER HSV SOL A	DEACTIVATE
5.11	42	P1299X	B IGN DETR DELAY-PU	DEACTIVATE
5.11	80	P1347X	S COF RELAY LOCKIN	DEACTIVATE
5.11	24	P1427X	VERN LO2 VENT CONT	ACTIVATE
5.11	22	P1503X	GFST VENT CTL	DEACTIVATE
5.11	39	P1510X	TCC VERN COMPLETE LT	DEACTIVATE
5.11	28	P1516X	VERN SQUIBS FIRING	DEACTIVATE
5.11	66	P1586X	S IGN FUEL V OPN CTL	DEACTIVATE
5.11	133	S1242X	SUS CUTOFF PRGR OTP	DEACTIVATE
5.11	137	S1246X	VERNIER COF PRGR OTP	DEACTIVATE
5.12	25	P1096X	VERN TKS PRES RELAY	DEACTIVATE
5.13	109-2	P1235P	VERN LO2 TK REG OUT	TRANSIENT 488 TO 505 TO 483 PSIG
5.17	209-2	P1048P	V2 LO2 INLET	DEC FROM 568 TO AMB /32 PSIG/
5.17	210-1	P1050P	V2 FUEL INLET	DEC FROM 514 PSIG TO AMB /67 PSIG/
5.19	209-3	P1049P	V1 FUEL INLET	DEC FROM 522 PSIG TO AMB /62 PSIG/
5.20	209-1	P1047P	V1 LO2 INLET	DEC FROM 549 PSIG TO AMB /32 PSIG/
5.21	110-3	P1075P	G FUEL START TANK	TANK VENTS
7.87	107-3	A1266D	MSL TK MOVEMENT Y AX	INC TO MINUS .020 INCHES
7.87	216-2	F1124P	S TK HE BTL DISCH	TRANS 2750 TO 3000 TO 2640 TO 2800 PSIG
7.87	113-1	F1142P	S CTL PNEU REG OUT	TRANSIENT 737 TO 798 TO 697 TO 736 PSIG
7.87	216-1	F1145P	S CTL HE BTL DISCH	TRANSIENT 2473 TO 2770 TO 2343 TO
7.87	216-1	F1145P	S CTL HE BTL DISCH	2484 PSIG
7.89	119-2	F1003P	FUEL TANK HELIUM	OSC 59.0 TO 52.5 PSIG FOR .5 SEC
7.92	109-2	P1235P	VERN LO2 TK REG OUT	TRANSIENT 483 TO 550 TO 453 TO 476 PSIG

7.93	110-2	P1236P	VERN FUEL TANK REG OUT	TRANSIENT 485 TO 530 TO 495 PSIG
7.93	119-3	P1332P	S LO2 PUMP DISCH	TRANSIENT 67 TO 82 TO 63 PSIG
7.94	214-1	H1052P	S HYD ACCUMULATOR	200 PSIG TRANSIENT
7.95	121-2	F1001P	LO2 TANK HELIUM	OSCILLATES 25.4 TO 28.3 PSIG
7.95	121-3	F1011P	LO2 PRES REG DISCH	OSCILLATES 7 PSIG
7.97	113-2	P1344P	S LO2 REG REF	OSC 82.6 FROM 771 PSIG FOR 1.8 SEC
8.87	216-1	F1145P	S CTL HE BTL DISCH	STEADY AT 2465 PSIG
9.37	218-3	P1341P	S LUBE PUMP GEAR	DEC FROM 32.2 PSIG TO AMB /17 PSIG/
11.02	117-3	P1006P	S THRUST CHAMBER	DEC FROM MAX TO AMB
12.09	122-2	P1004P	B2 FUEL PUMP INLET	TRACE NOISY FOR 8.8 SEC @ MINUS 2.5 PSI
12.87	213-3	H1141T	V HYD OIL SUPPLY	TEMP INC
13.36	5	P1581X	S FUEL PRE VLV OPEN	DEACTIVATE
13.51	CEC	P1055P	S FUEL PUMP INLET	DEC FROM 28.5 PSIG TO 12.7 PSIG
14.02	7	P1443X	LO2 PRE VALVE OPEN	DEACTIVATE
15.10	4	P1580X	S FUEL PRE VLV CLSD	ACTIVATE
17.73	123-3	P1056P	S LO2 PUMP INLET	DEC FROM 45 PSIG TO 25 PSIG
17.87	122-1	P1003P	B2 LO2 PUMP IN	DEC FROM 34 PSIG TO 29 PSIG
17.87	6	P1444X	LO2 PRE VALVE CLOSED	ACTIVATE
17.97	123-1	P1001P	B1 LO2 PUMP IN	DEC FROM 52 PSIG TO 30 PSIG
20.67	220-2	P1014T	ENGINE COMP AMB	DEC FROM PLUS PEG TO 105.0 DEG F IN 10
20.67	220-2	P1014T	ENGINE COMP AMB	SEC
20.87	107-2	A1264D	MSL TK MOVEMENT X AX	DEC TO MINUS .270 INCHES
20.87	122-2	P1004P	B2 FUEL PUMP INLET	TRACE STABLE NEAR 0 PSIG
21.37	208-3	P1280P	SGG FUEL VLV INLET	BEGAN RANDON NOISE
22.87	107-3	A1266D	MSL TK MOVEMENT Y AX	DEC TO MINUS .050 INCHES
24.38	86	P1588X	S TBN OVERSPEED TRIP	DEACTIVATE

34.87	123-3	P1056P	S LO2 PUMP INLET	DEC FROM 27 PSIG TO 10 PSIG
35.87	213-1	H1140P	V HYD PUMP DISCH	INC FROM 1970 TO 3260 PSIG
35.87	123-1	P1001P	B1 LO2 PUMP IN	DEC FROM 30 PSIG TO 0 PSIG
35.87	122-1	P1003P	B2 LO2 PUMP IN	DEC FROM 28 PSIG TO 0 PSIG
40.87	117-2	P1336T	S GAS GEN DISCH	INC FROM PEG NEG TO 75 DEG F
47.87	107-3	A1266D	MSL TK MOVEMENT Y AX	INC TO MINUS .022 INCHES
47.87	113-1	F1142P	S CTL PNEU REG OUT	BEGAN OSCILLATION
47.87	123-3	P1056P	S LO2 PUMP INLET	BEGAN RANDOM OSCILLATIONS
47.87	115-3	P1060P	B1 THRUST CHAMBER	OSCILLATES PLUS THEN PEGS MINUS
48.87	119-2	F1003P	FUEL TANK HELIUM	DEC SEG III TO II /22.9 PSIG/ IN 113 SE
48.87	115-2	P1059P	B2 THRUST CHAMBER	OSCILLATES PLUS THEN PEGS MINUS
48.87	113-2	P1344P	S LO2 REG REF	BEGAN RANDOM NOISE
49.87	111-2	P1026P	B LO2 REG REF	OSCILLATES PLUS THEN PEGS MINUS
51.87	113-3	P1177P	B LO2 START TANK REG	RANDOM OSCILLATIONS
52.87	216-2	F1124P	S TK HE BTL DISCH	BEGAN OSCILLATION
52.87	111-1	F1125P	B CTL PNEU REG	BEGAN OSCILLATION
52.87	216-1	F1145P	S CTL HE BTL DISCH	BEGAN OSCILLATION
52.87	212-3	H1131T	S HYD PUMP DISCH	INC 20 DEG F
53.37	109-2	P1235P	VERN LO2 TK REG OUT	BEGAN RANDOM TRANSIENTS
54.37	110-2	P1236P	VERN FUEL TANK REG OUT	BEGAN RANDOM OSCILLATIONS
72.87	107-3	A1266D	MSL TK MOVEMENT Y AX	DEC TO MINUS .090 INCHES
88.87	221-1	E1027V	PROP CONTROL INPUT	ERRATIC TRACE
556.37	220-2	P1014T	ENGINE COMP AMB	TRANSIENT 75.5 TO 97.6 TO 70.5 DEG F
	8		SPARE	DEACTIVATE
	9		SPARE	ACTIVATE
	33		SPARE	DEACTIVATE

CONFIDENTIAL

34		SPARE	DEACTIVATE
37		SPARE	DEACTIVATE
62		SPARE	DEACTIVATE
76		SPARE	DEACTIVATE
89		SPARE	DEACTIVATE
94		SPARE	DEACTIVATE
95		SPARE	DEACTIVATE
96		SPARE	DEACTIVATE
97		SPARE	DEACTIVATE
98		SPARE	DEACTIVATE
111		SPARE	DEACTIVATE
117		SPARE	DEACTIVATE
119		SPARE	DEACTIVATE
120		SPARE	DEACTIVATE
123		SPARE	DEACTIVATE
124		SPARE	DEACTIVATE
125		SPARE	DEACTIVATE
142		SPARE	DEACTIVATE
143		SPARE	DEACTIVATE
144		SPARE	DEACTIVATE
145		SPARE	DEACTIVATE
146		SPARE	DEACTIVATE
213-1	H1140P	V HYD PUMP DISCH	PRE START STEADY 1900 PSIG
19	H1066X	APS HYD UNDER PRESS	DEACTIVATE
60	P1072X	B COF RELAY LOCKIN	DEACTIVATE
44	P1129X	B LUBE TANK PRESD SW	DEACTIVATE

90	P1136X	B IGN DETR DELAY COF	DEACTIVATE
43	P1144X	B LUBE TNK PRESS SOL	DEACTIVATE
57	P1145X	BGG VLV OPEN CTL SOL	DEACTIVATE
115	P1146X	BGG VLV CLOS CTL SOL	DEACTIVATE
59	P1147X	BGG VLV OPEN MSW	DEACTIVATE
52	P1148X	B FUEL VLV OPEN CTL SOL	DEACTIVATE
114	P1150X	B FUEL VLV CLOS CTL SOL	DEACTIVATE
108	P1154X	TCC B ENGINE COF SW	DEACTIVATE
91	P1155X	OBSERVER CUTOFF	DEACTIVATE
87	P1156X	B1 TBN OVRSPEED TRIP	DEACTIVATE
88	P1157X	B2 TBN OVRSPEED TRIP	DEACTIVATE
92	P1158X	PREP INCOMPLETE COF	DEACTIVATE
100	P1159X	B LUBE TK PRESS COF	DEACTIVATE
110	P1164X	TCC VERN ENG COF SW	DEACTIVATE
20	P1186X	TCC FUEL S T FULL LT	DEACTIVATE
83	P1192X	B1 ROUGH COMB COF	DEACTIVATE
84	P1193X	B2 ROUGH COMB COF	DEACTIVATE
54	P1194X	B1 FUEL VLV OPEN MSW	DEACTIVATE
56	P1195X	B2 FUEL VLV OPEN MSW	DEACTIVATE
71	P1200X	SUSTAINER PUV SOL F	DEACTIVATE
75	P1201X	SUSTAINER PUV SOL E	DEACTIVATE
73	P1202X	S FUEL PUV OPEN MSW	DEACTIVATE
72	P1203X	S FUEL PUV CLSD MSW	ACTIVATE
149	P1219X	#1 OBSERVER CUTOFF	DEACTIVATE
150	P1220X	#2 OBSERVER CUTOFF	DEACTIVATE
151	P1221X	#3 OBSERVER CUTOFF	DEACTIVATE

152	P1222X	#4 OBSERVER CUTOFF	DEACTIVATE
153	P1223X	#5 OBSERVER CUTOFF	DEACTIVATE
154	P1224X	#6 OBSERVER CUTOFF	DEACTIVATE
155	P1225X	#7 OBSERVER CUTOFF	DEACTIVATE
156	P1226X	#8 OBSERVER CUTOFF	DEACTIVATE
157	P1227X	#9 OBSERVER CUTOFF	DEACTIVATE
158	P1228X	#10 OBSERVER CUTOFF	DEACTIVATE
159	P1229X	#11 OBSERVER CUTOFF	DEACTIVATE
160	P1230X	#12 OBSERVER CUTOFF	DEACTIVATE
147	P1231X	OBSERVER CUTOFF N TANK	DEACTIVATE
148	P1232X	OBSERVER CUTOFF S TANK	DEACTIVATE
78	P1335X	SGG VALVE CLSD MSW	ACTIVATE
10	P1379X	APS ARM	DEACTIVATE
13	P1381X	APS RUN	DEACTIVATE
14	P1382X	APS IGNITION	DEACTIVATE
15	P1383X	APS COMPOSIT VLV SOL	DEACTIVATE
16	P1386X	APS READY TO COMMIT	DEACTIVATE
17	P1388X	APS COMMIT	DEACTIVATE
18	P1390X	APS SPEED SHUTDOWN	DEACTIVATE
70	P1429X	TCC RELEASE SWITCH	DEACTIVATE
85	P1438X	ROUGH COMB COF S	DEACTIVATE
35	P1441X	B IGN STAGE TIMER-DO	DEACTIVATE
2	P1446X	B FUEL PRE VLV CLSD	DEACTIVATE
79	P1499X	SGG VLV OPEN MSW	DEACTIVATE
82	P1515X	VERN SRT DY COF	DEACTIVATE
40	P1519X	VERN STRT DY COF TMR	DEACTIVATE

~~CONFIDENTIAL~~

103	P1561X	o LO2 REF REG VENT	DEACTIVATE
12	P1575X	PRE START READY	DEACTIVATE
63	P1583X	S FUEL VLV LOKUP CTL	DEACTIVATE
64	P1584X	S FUEL TK PRESS SOL	DEACTIVATE
65	P1585X	S LUBE TNK PRESS SW	DEACTIVATE
77	P1587X	S GG VLV OPEN CTL	DEACTIVATE
104	P1591X	S HYD PRESS SW	ACTIVATE
105	P1592X	BOOSTER ENG CUTOFF	DEACTIVATE
106	P1593X	SUSTAINER ENG CUTOFF	DEACTIVATE
109	P1594X	TCC SUSTAINER COF SW	DEACTIVATE
116	P1595X	SGG VLV CLOSING SOL	DEACTIVATE
118	P1596X	HOLD DN PRE-LEASE	DEACTIVATE
99	P1597X	S LUBE TK PRESS COF	DEACTIVATE
126	S1235X	PROGRAMER RUN TIME	DEACTIVATE
127	S1236X	BOOSTER COF DISCRETE	DEACTIVATE
129	S1238X	JETTISON BOOSTER SIG	DEACTIVATE
130	S1239X	PRES VERN TKS DISC	DEACTIVATE
132	S1241X	SUSTAINER COF DISC	DEACTIVATE
134	S1243X	PRE-ARM DISCRETE	DEACTIVATE
135	S1244X	PRE-ARM PRGR OTP	DEACTIVATE
136	S1245X	VERNIER COF DISCRETE	DEACTIVATE
138	S1247X	RLS IN-FLIGHT DISCON	DEACTIVATE
139	S1248X	RELEASE NOSE CONE	DEACTIVATE
140	S1249X	FIRE RETRO-ROCKET	DEACTIVATE
122	ST215X	VIB PRINTER TIME	OPERATED EACH 1.5 SEC

APPENDIX E

PHOTOGRAPHS OF DAMAGE

RUN S2-212-B4-01

CONVAIR ASTRONAUTICS

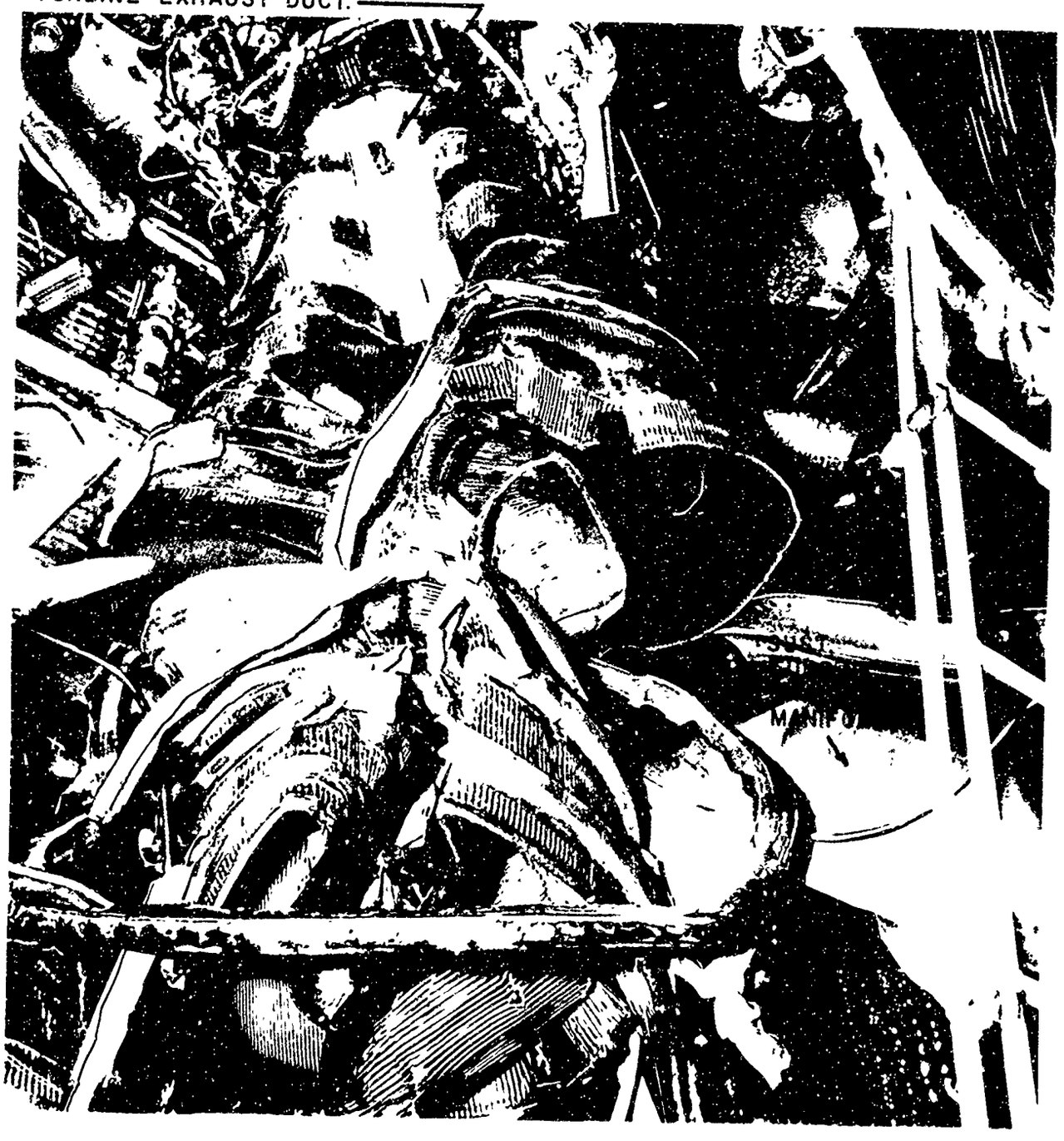


PHOTO No. 1
SUSTAINER THRUST CHAMBER

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

PHOTO No. 2

VIEW BETWEEN B1 & SUSTR. THRUST CHAMBERS

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

PHOTO No. 3
THRUST SECTION QUARDS III & IV

CONVAIR ASTRONAUTICS

PHOTO No.4
BOOSTER LUBE OIL TANK

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

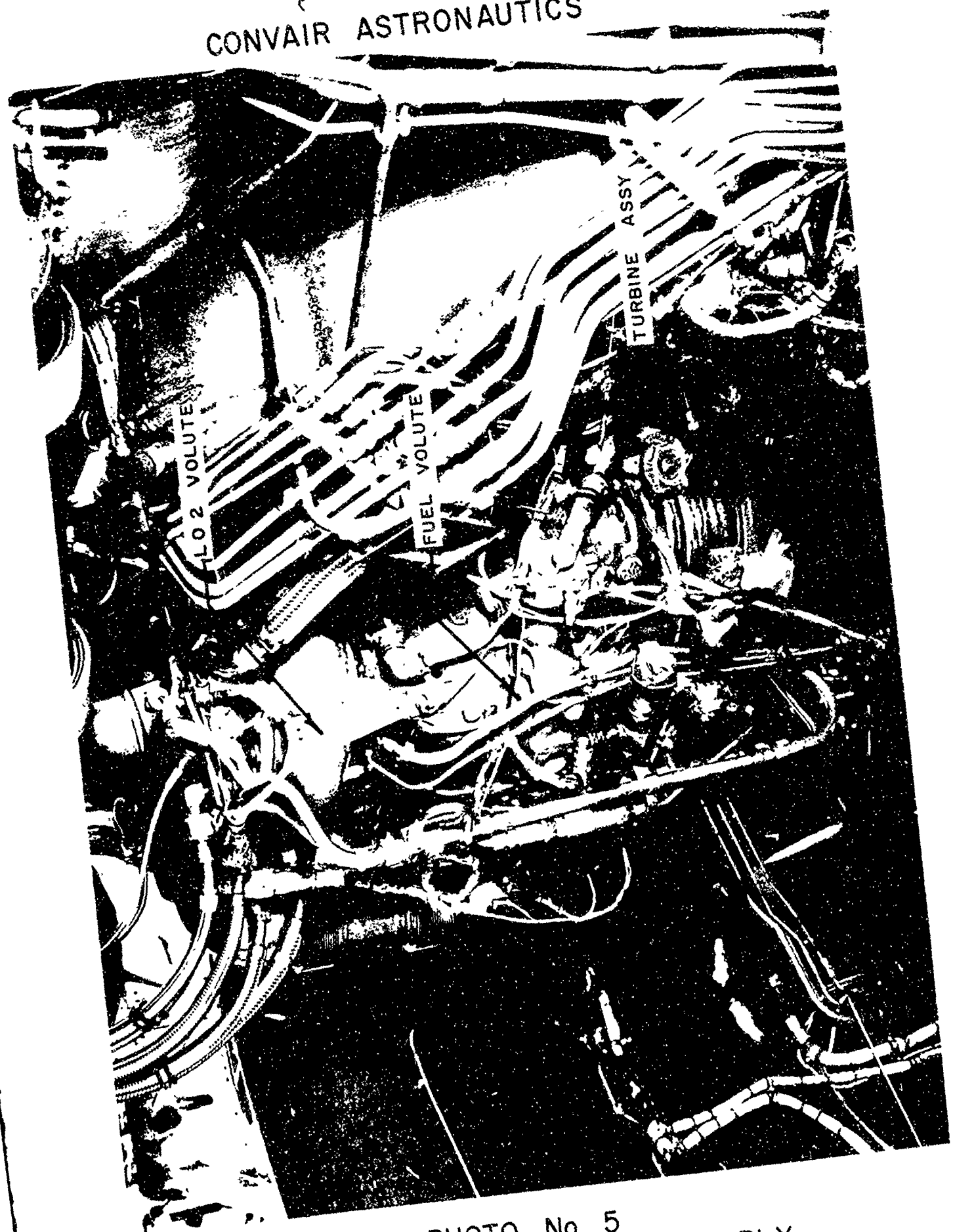


PHOTO No. 5
SUSTR. TURBO PUMP ASSEMBLY

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

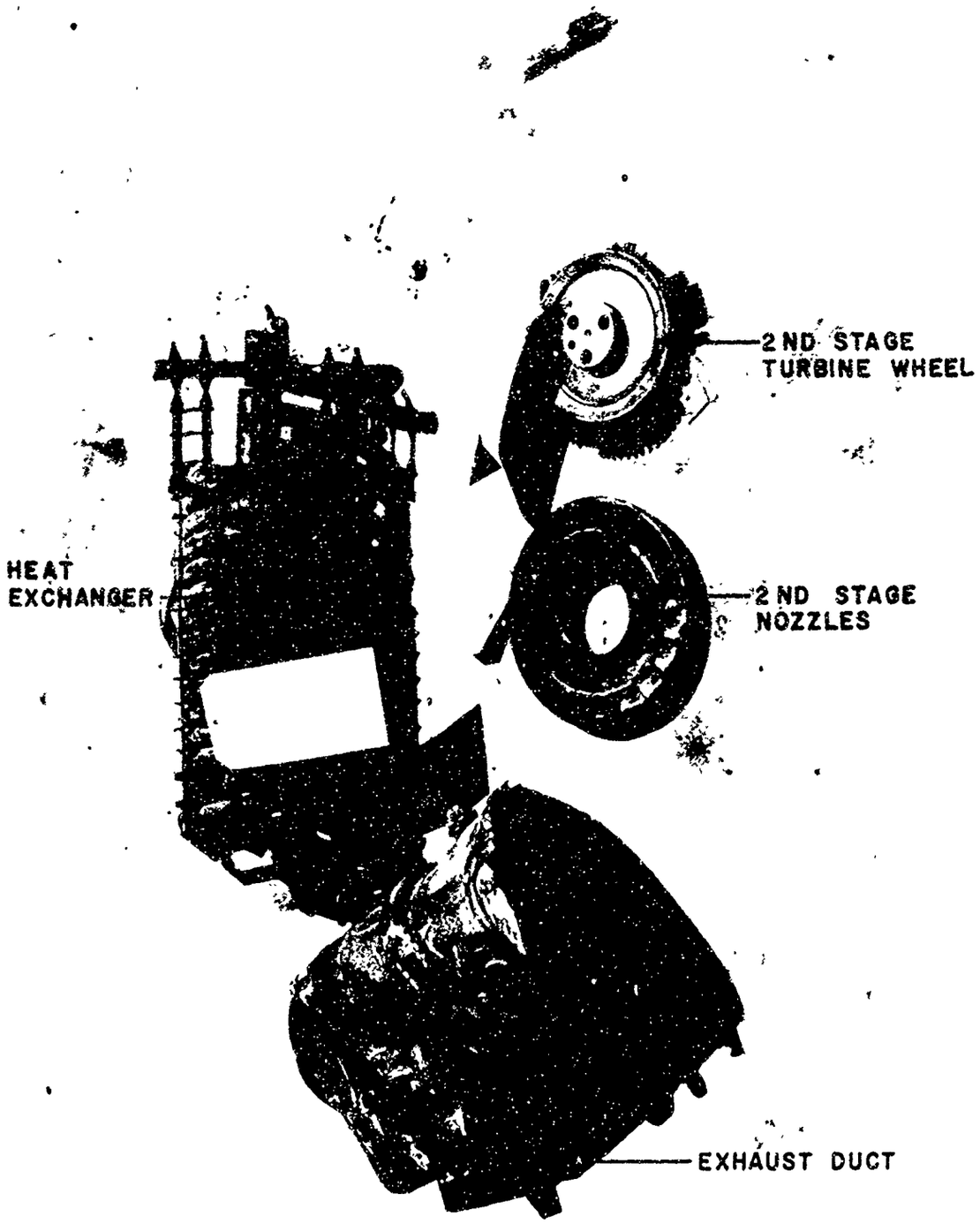


PHOTO No. 6
MAJOR SUSTAINER ENGINE PARTS
EJECTED BY THE EXPLOSION

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

PHOTO No. 7
BOOSTER TURBINE EXHAUST &
SUSTAINER TURBINE EXHAUST MANIFOLD

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

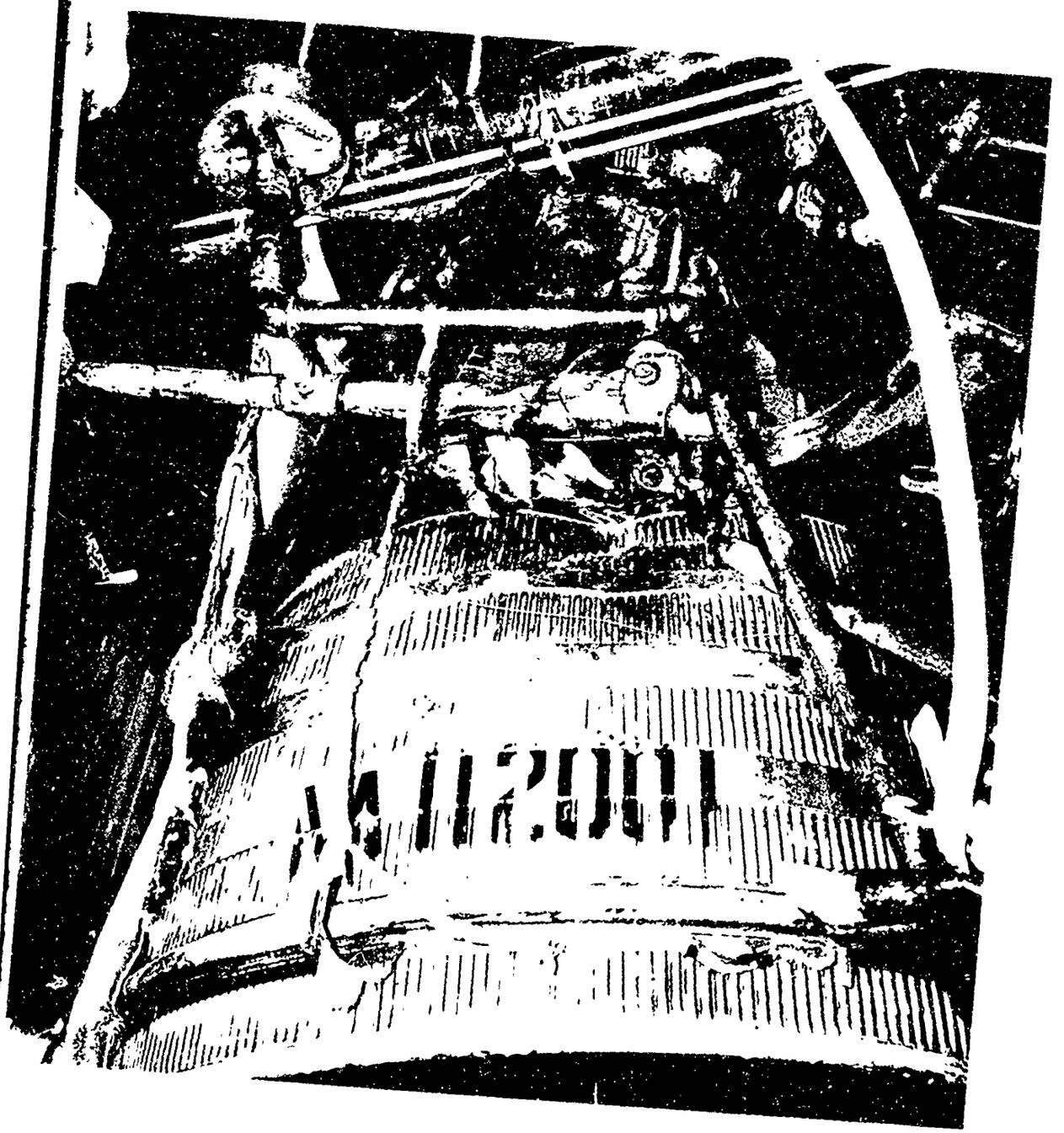


PHOTO No. 8
BI THRUST CHAMBER

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

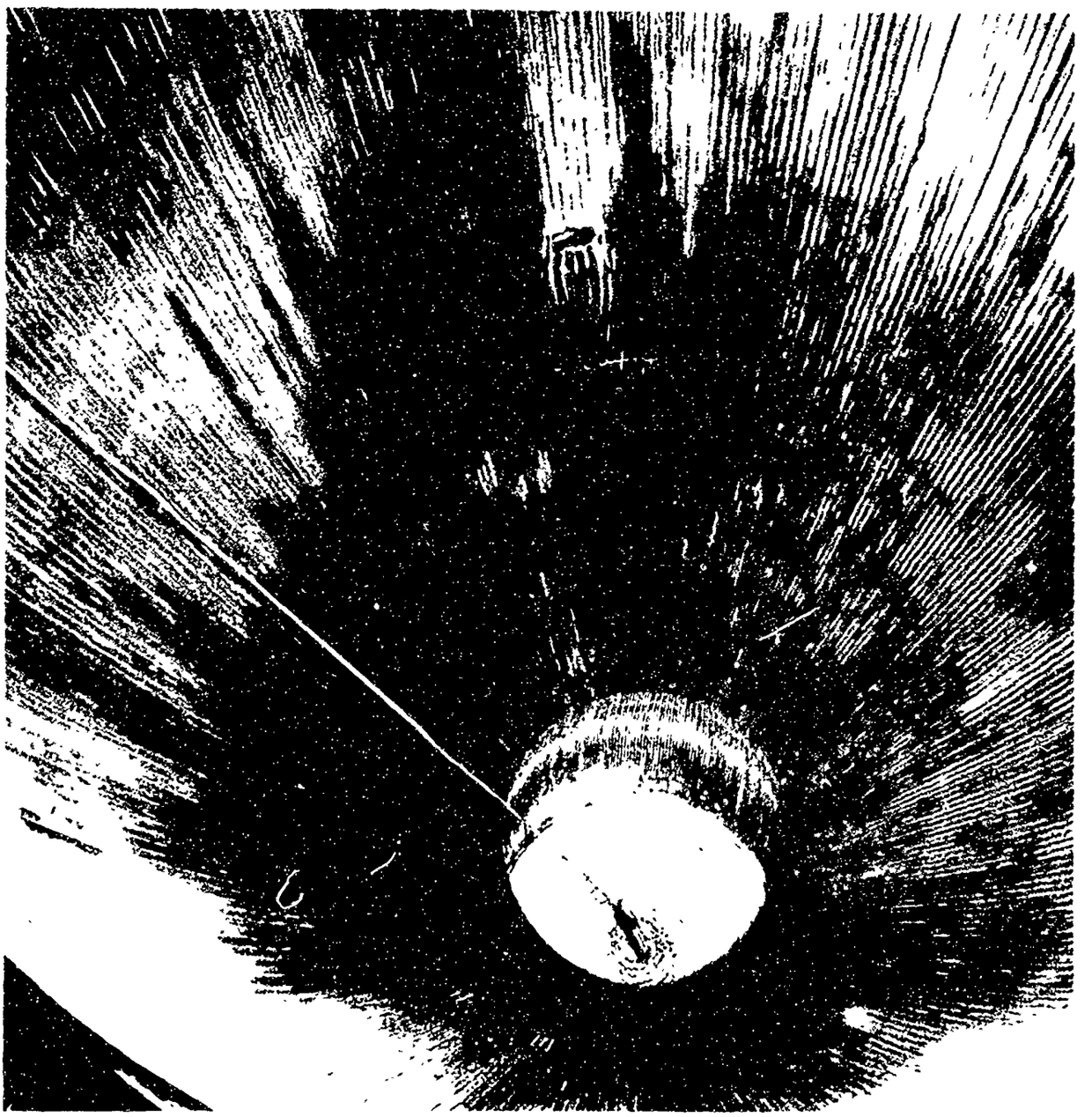


PHOTO No. 9
INTERIOR OF B I CHAMBER

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

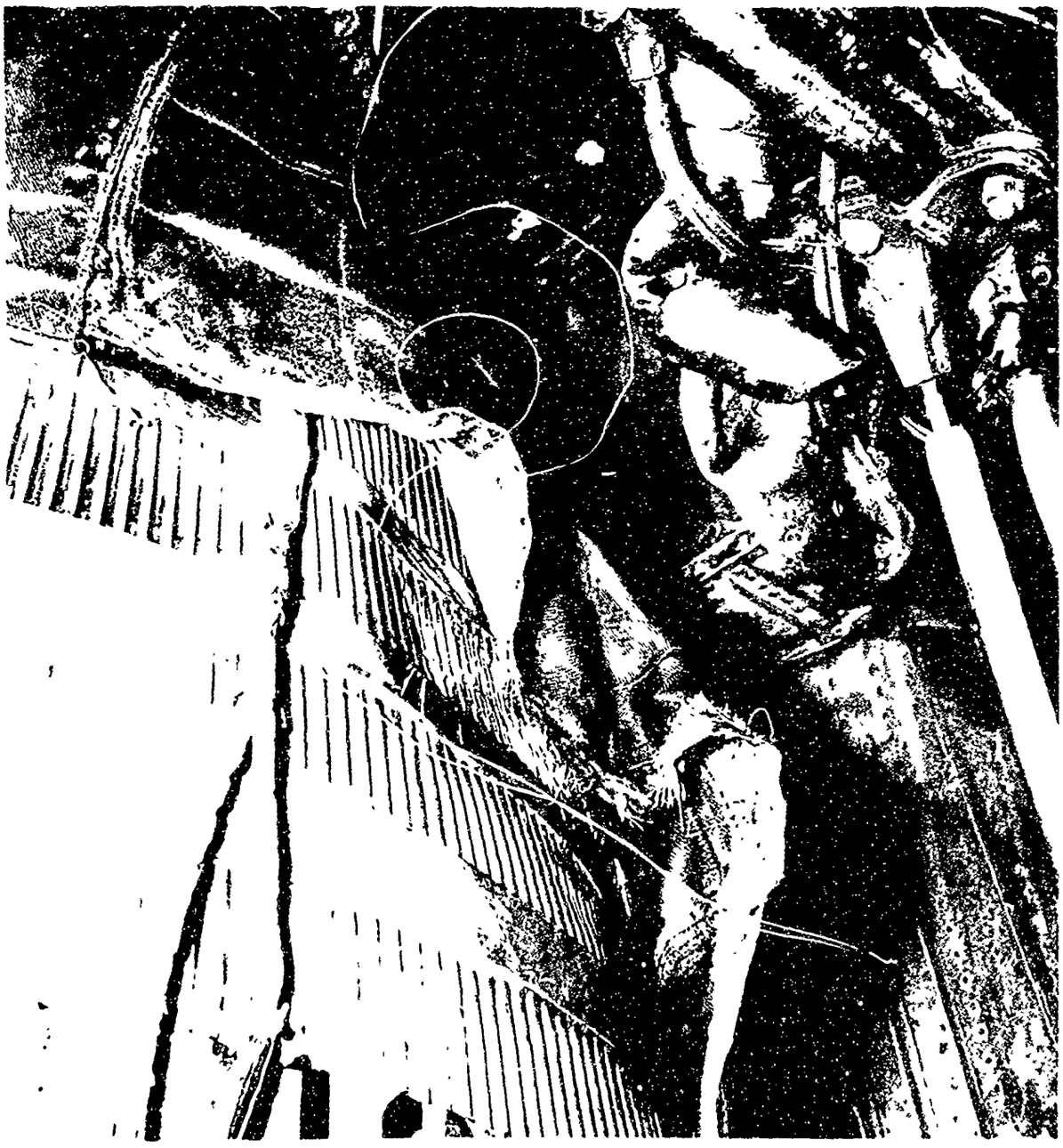


PHOTO No. 10
B2 THRUST CHAMBER

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

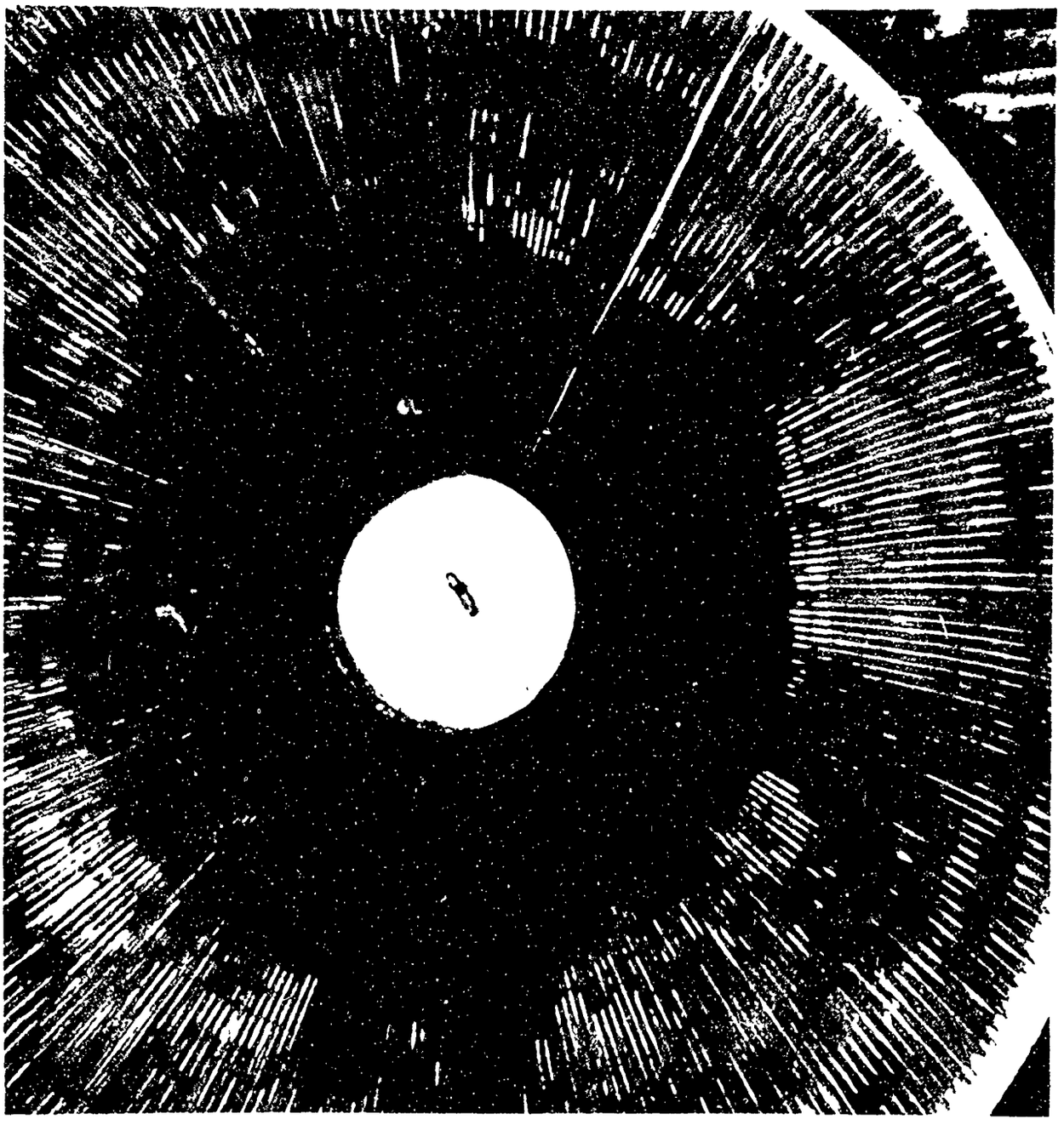


PHOTO No. 11
INTERIOR OF B2 CHAMBER

~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

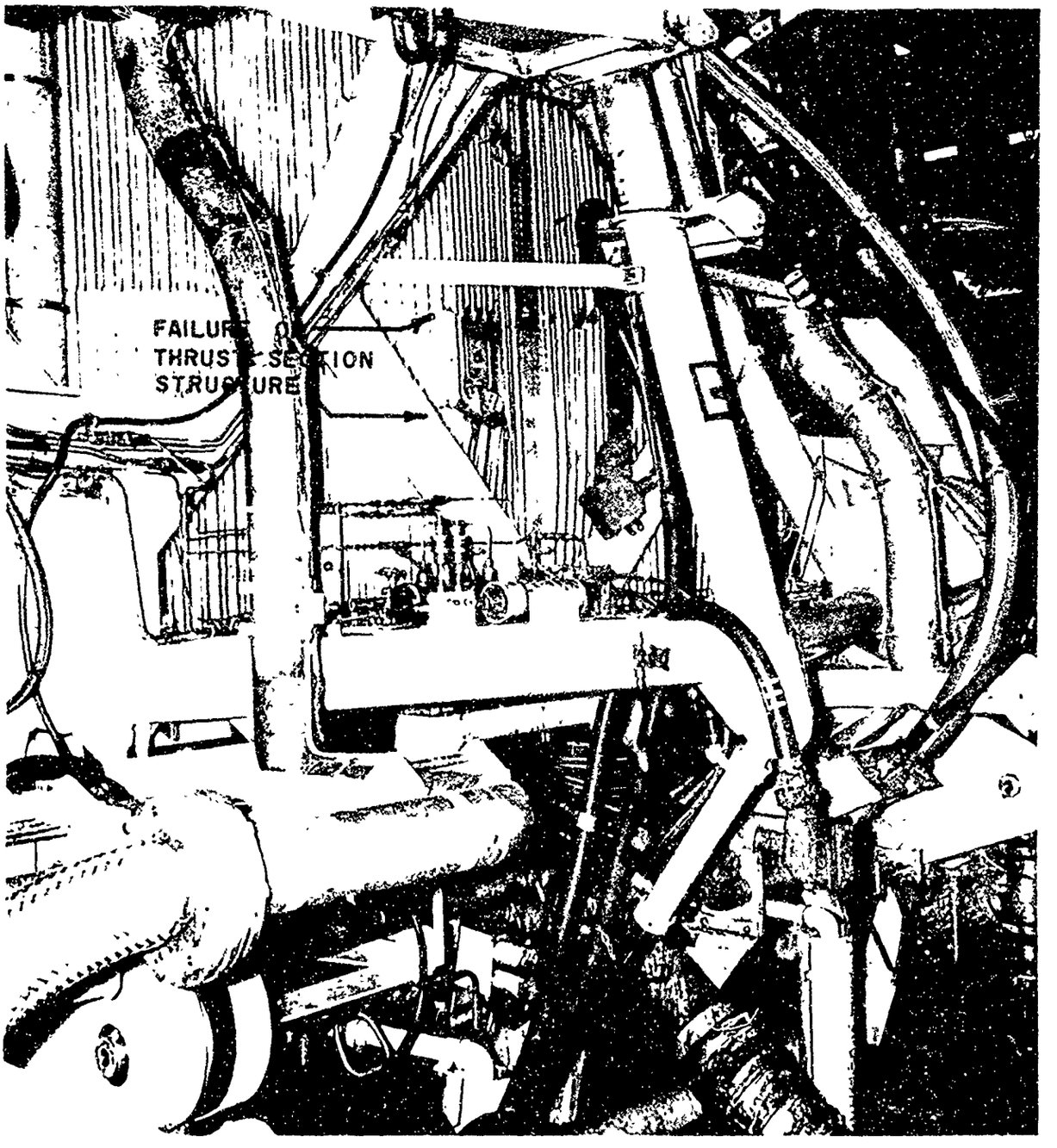


PHOTO No. 12
EXTERIOR SKIRT DAMAGE
QUAD IV AND EJECTED UMBILICALS

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

PHOTO No. 13
PURGE RISE OFF PANEL

CONVAIR ASTRONAUTICS

PHOTO No. 14
FAIRING DAMAGE INTERIOR OF QUAD I

CONVAIR ASTRONAUTICS

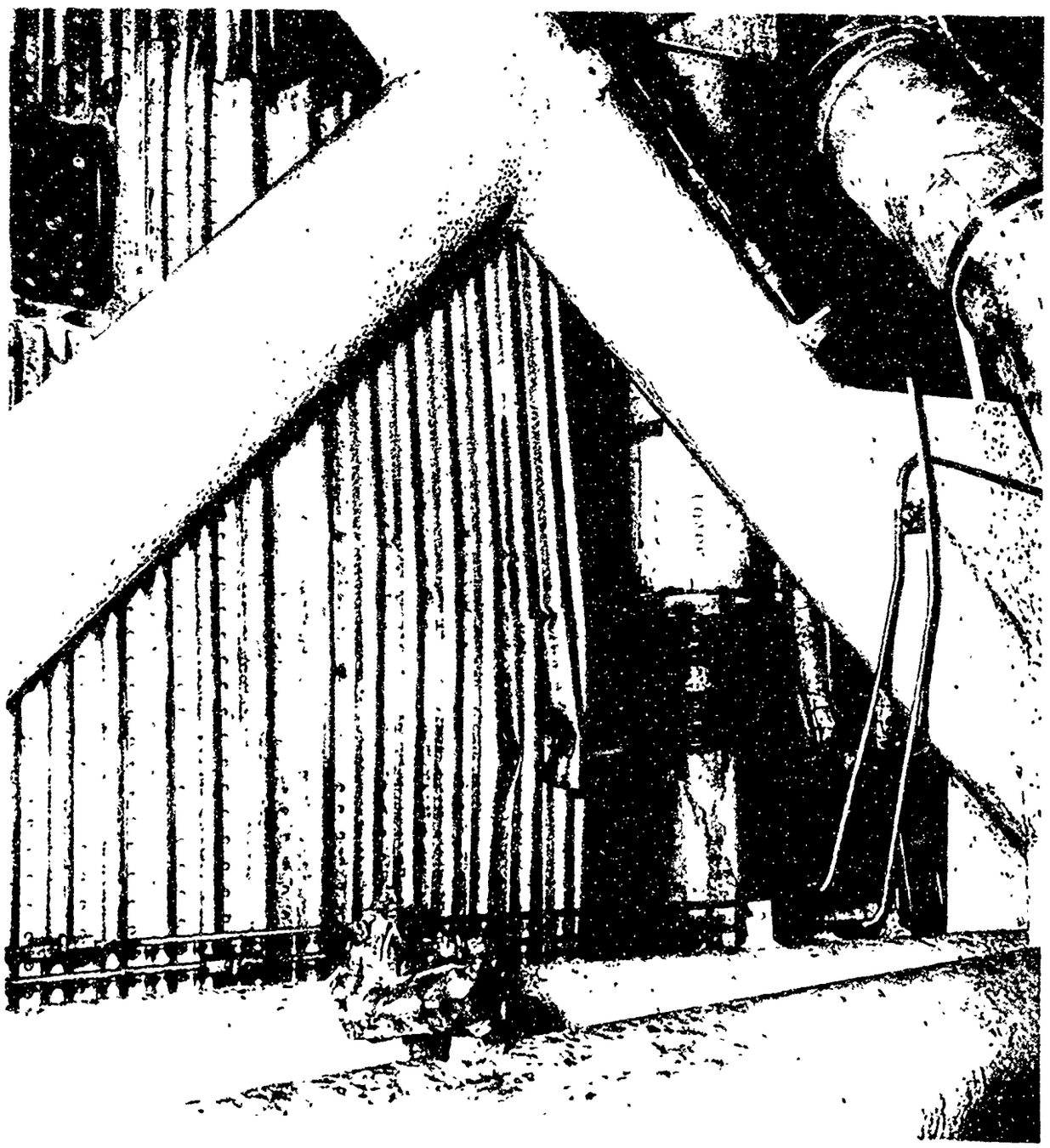


PHOTO No. 15
FAIRING DAMAGE QUAD IV

CONVAIR ASTRONAUTICS

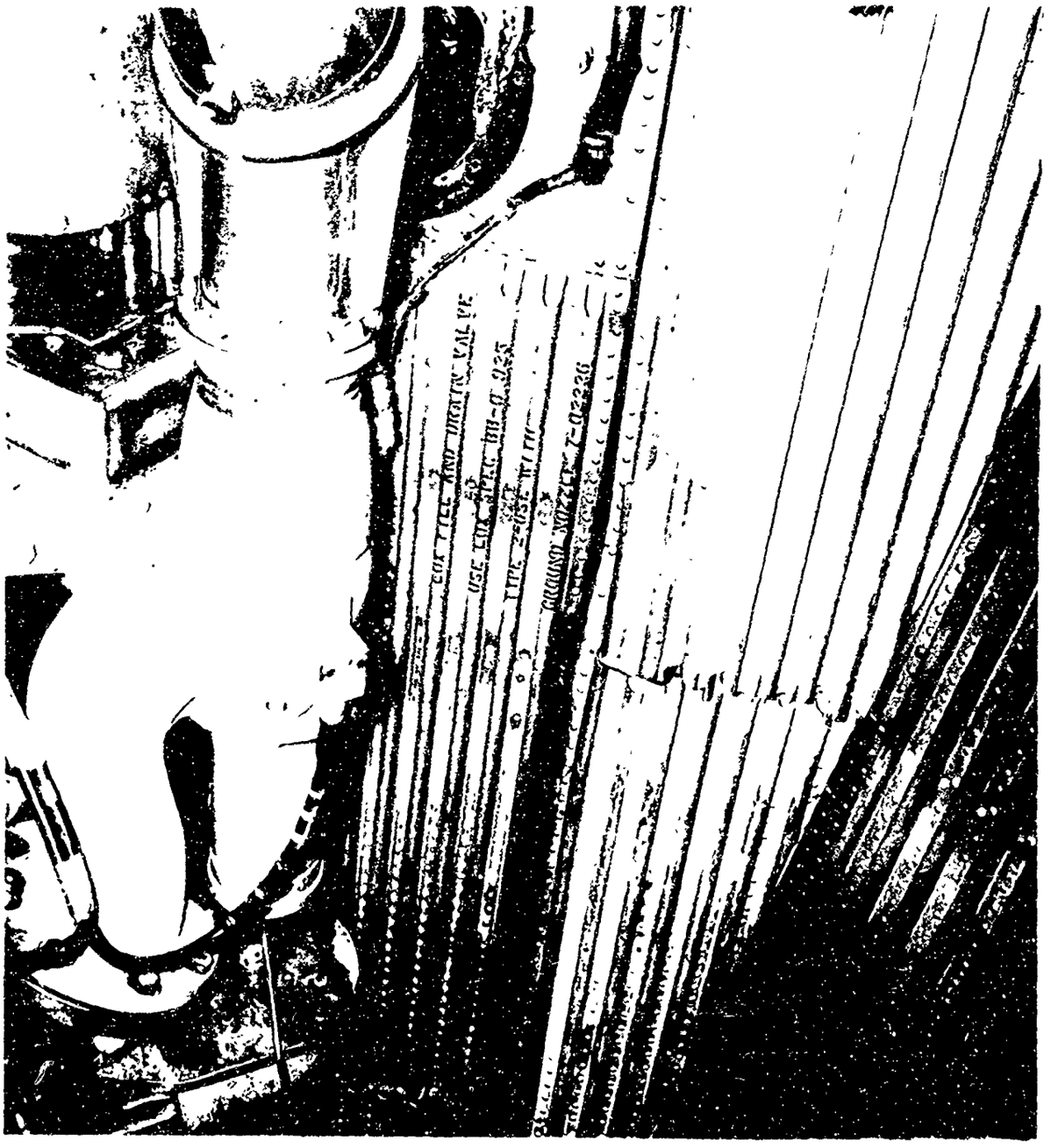


PHOTO No. 16
FAIRING DAMAGE QUAD IV

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

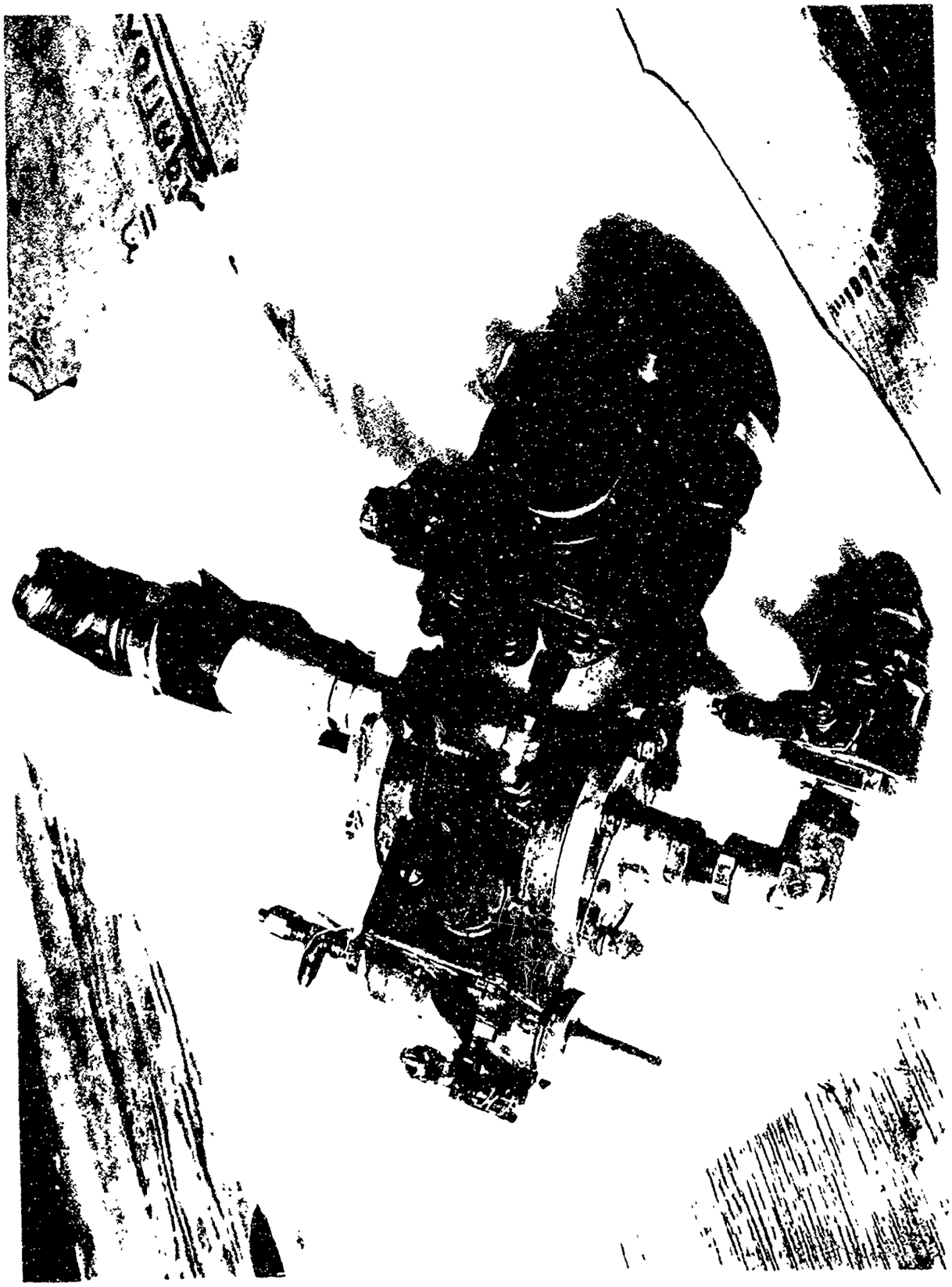


PHOTO No. 17
SUSTAINER GAS GENERATOR
AS REMOVED FROM MISSILE

~~CONFIDENTIAL~~

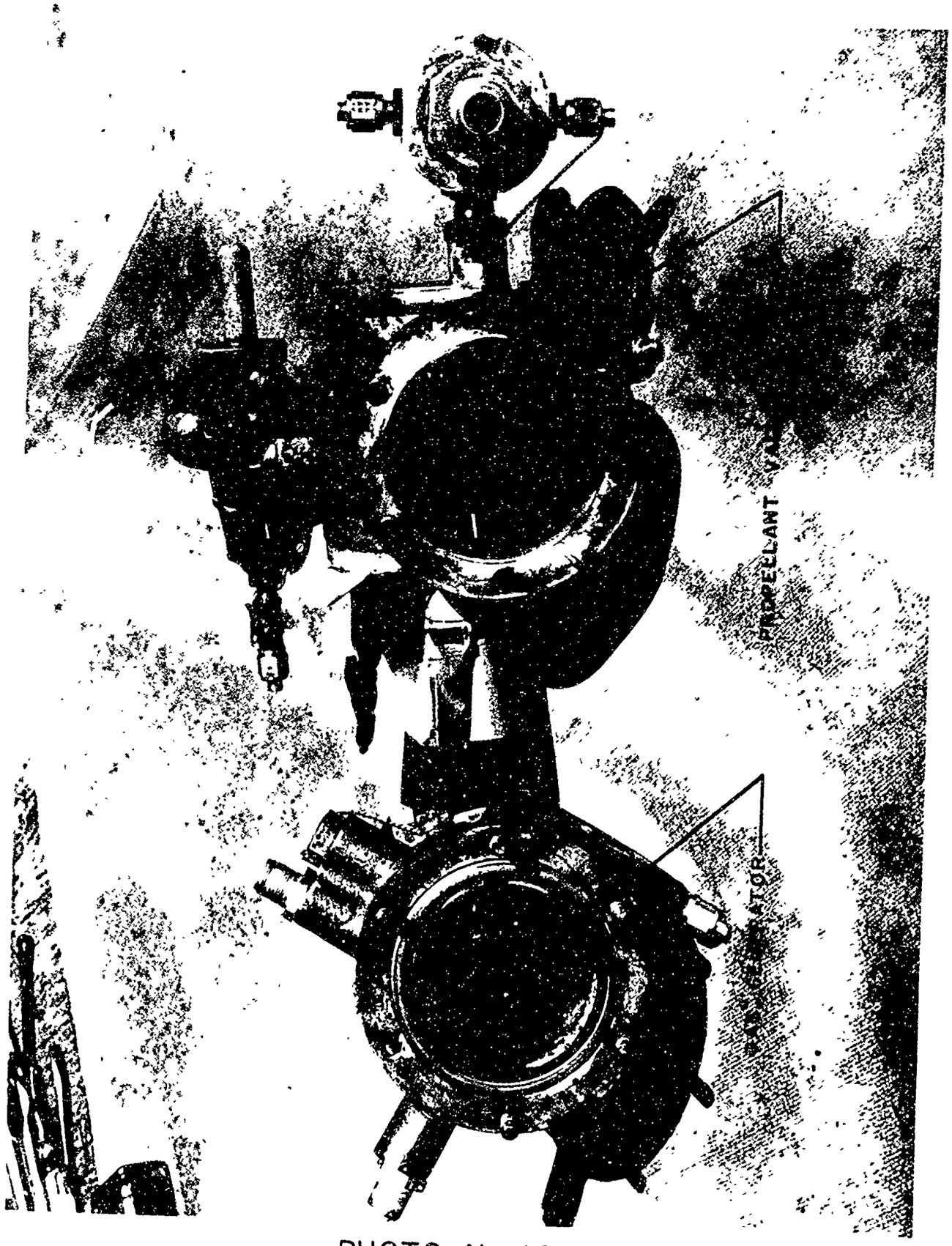


PHOTO No. 18
SUSTAINER PROPELLANT VALVE
ASSEMBLY REMOVED FROM GAS GENERATOR

CONVAIR ASTRONAUTICS

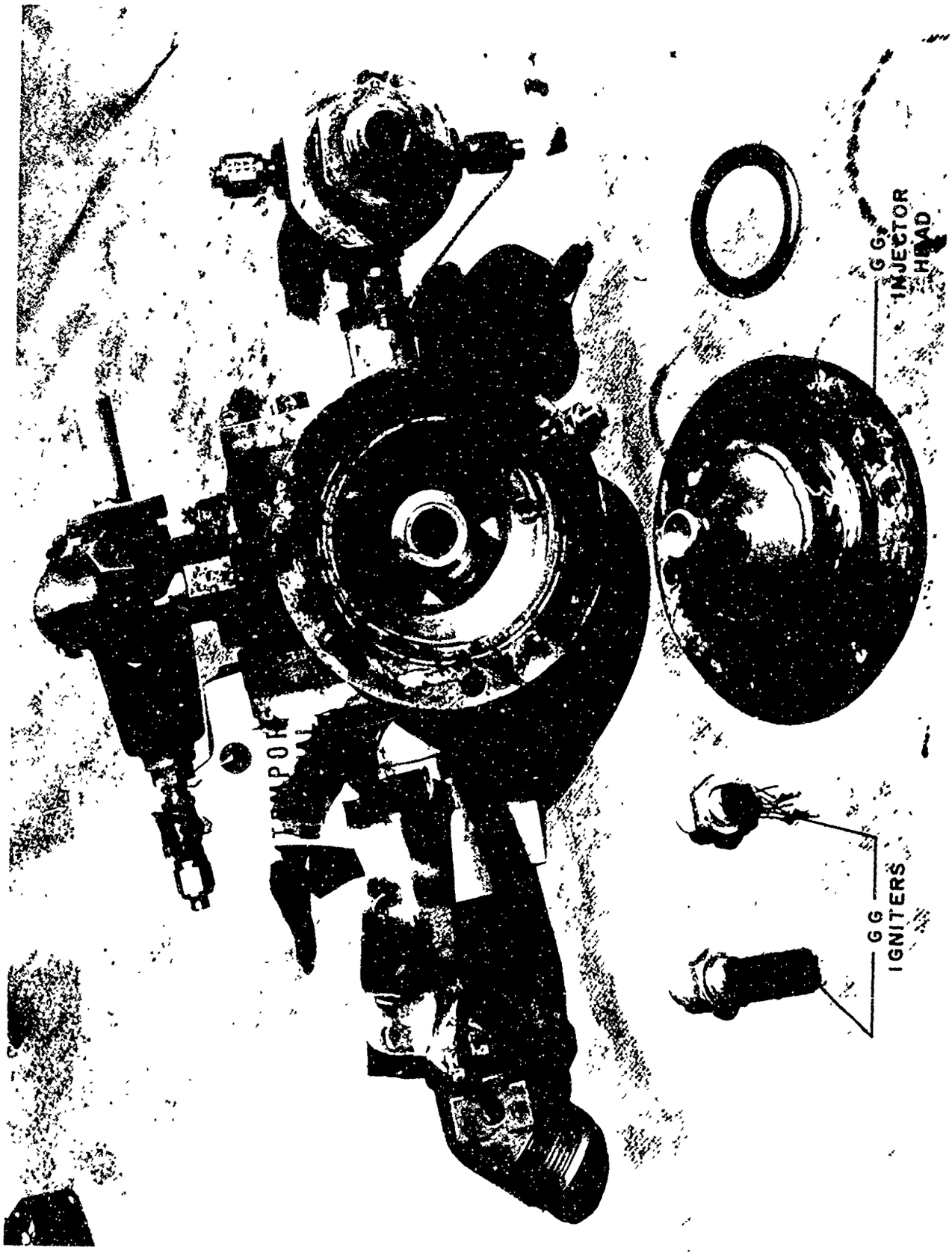


PHOTO No. 19
PROPELLANT VALVE ASSEMBLY
WITH INJECTOR HEAD REMOVED

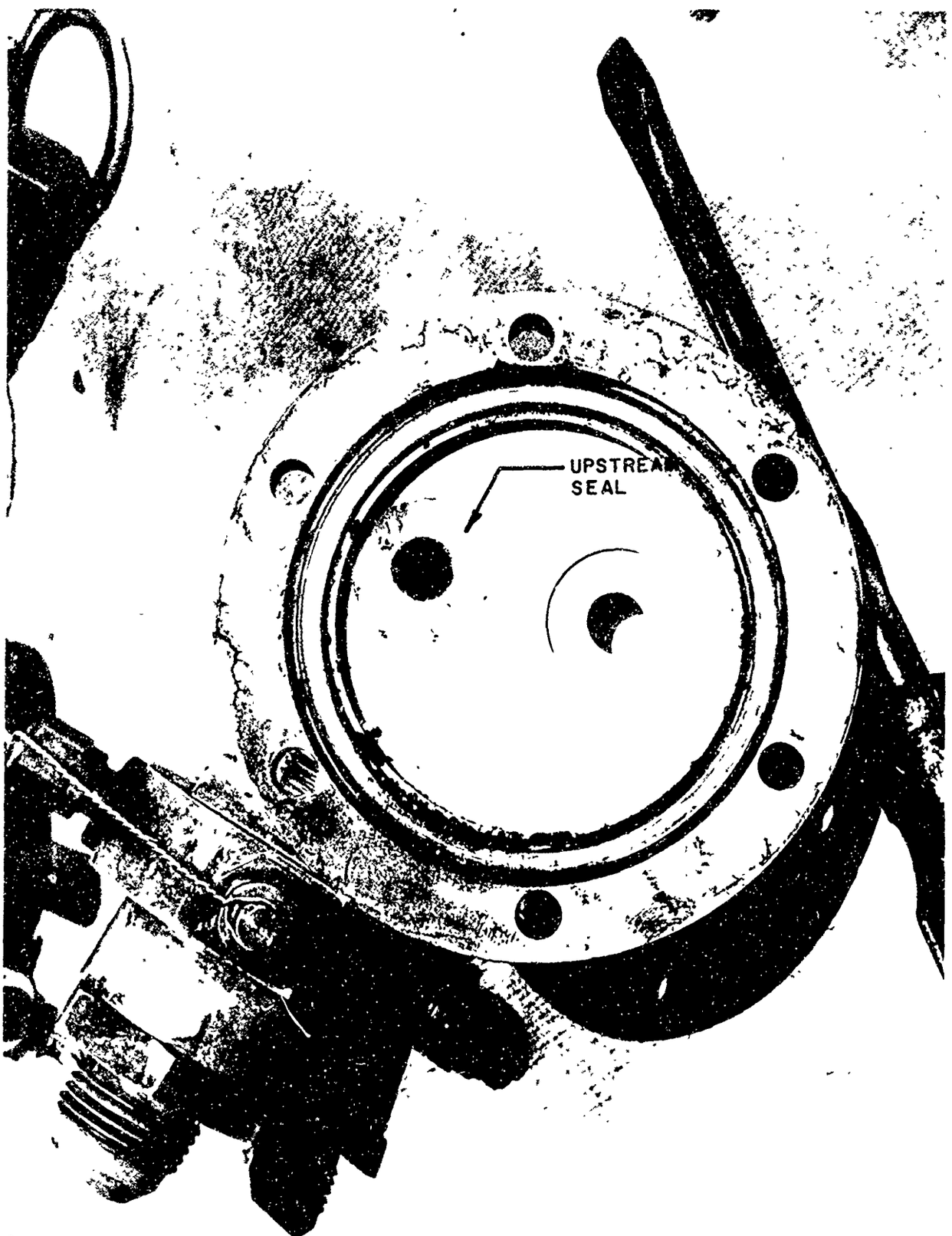


PHOTO No. 20
LO_2 BLADE VALVE COVER PLATE
SHOWING CRACKED UPSTREAM SEAL

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

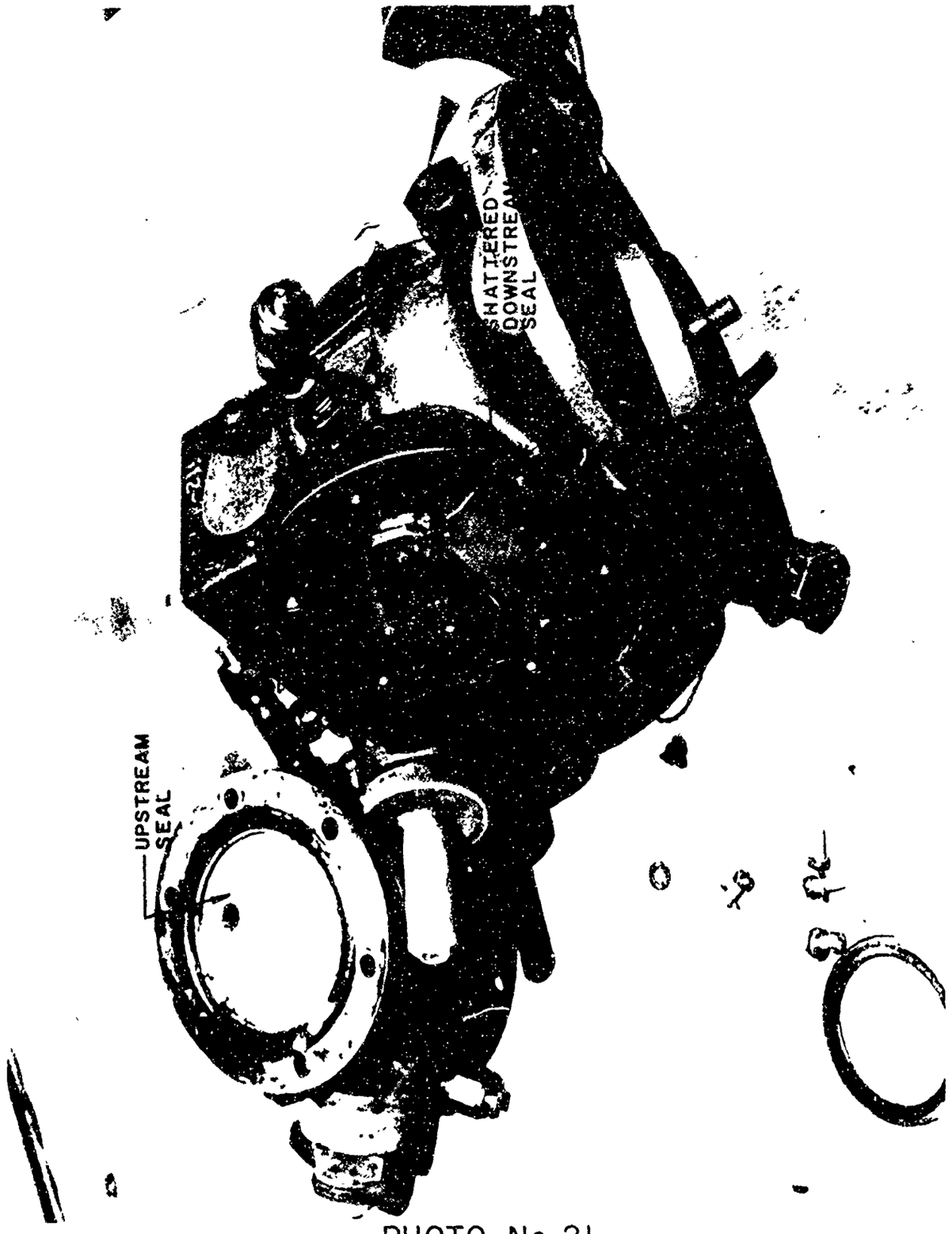


PHOTO No. 21
LO_2 BLADE VALVE SHOWING
SHATTERED DOWNSTREAM SEAL AND
POSITION OF VALVE WHEN DISASSEMBLED
VIEW I

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

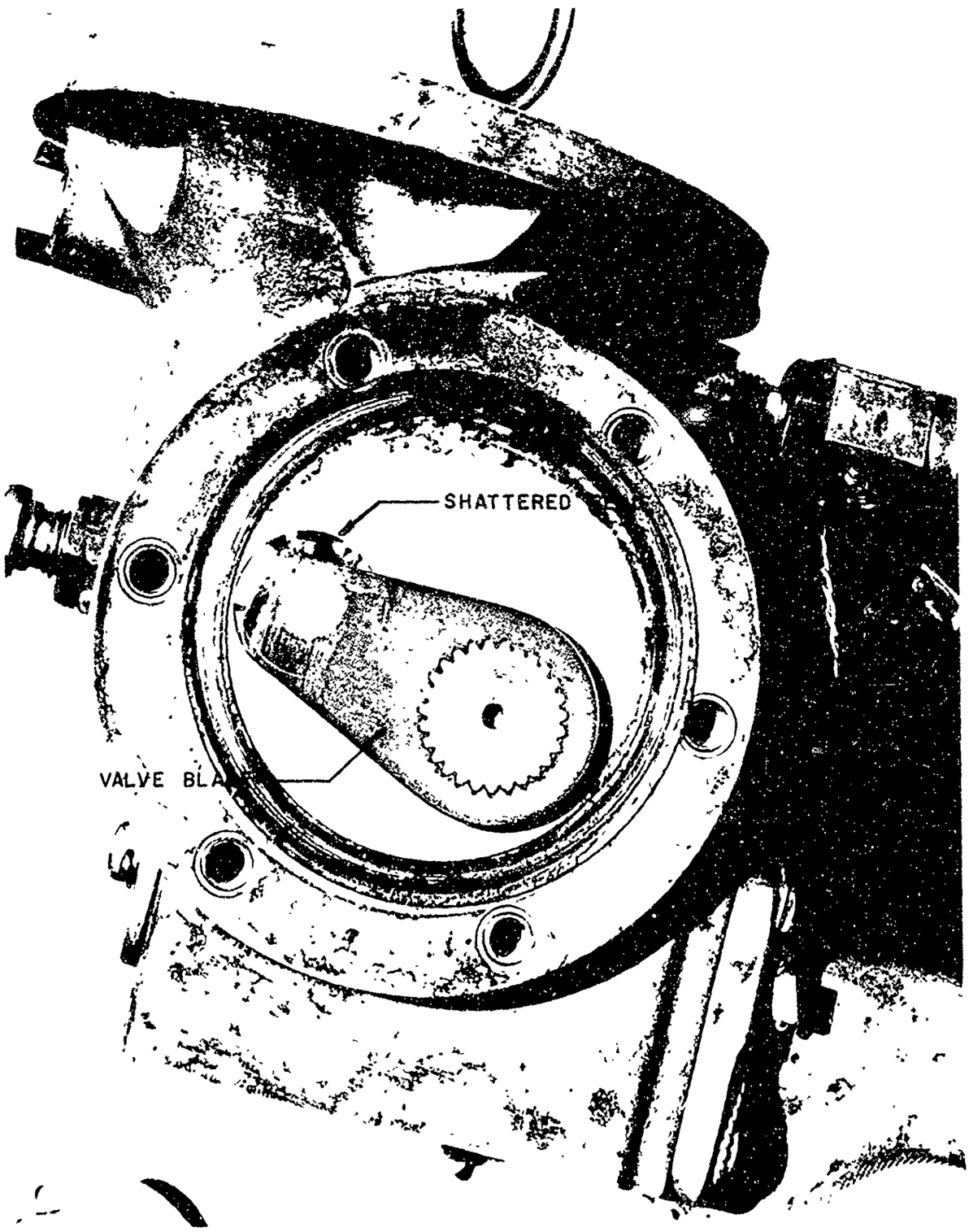


PHOTO No. 22
LO_2 BLADE VALVE SHOWING
SHATTERED DOWNSTREAM SEAL AND
POSITION OF VALVE WHEN DISASSEMBLED
VIEW 2

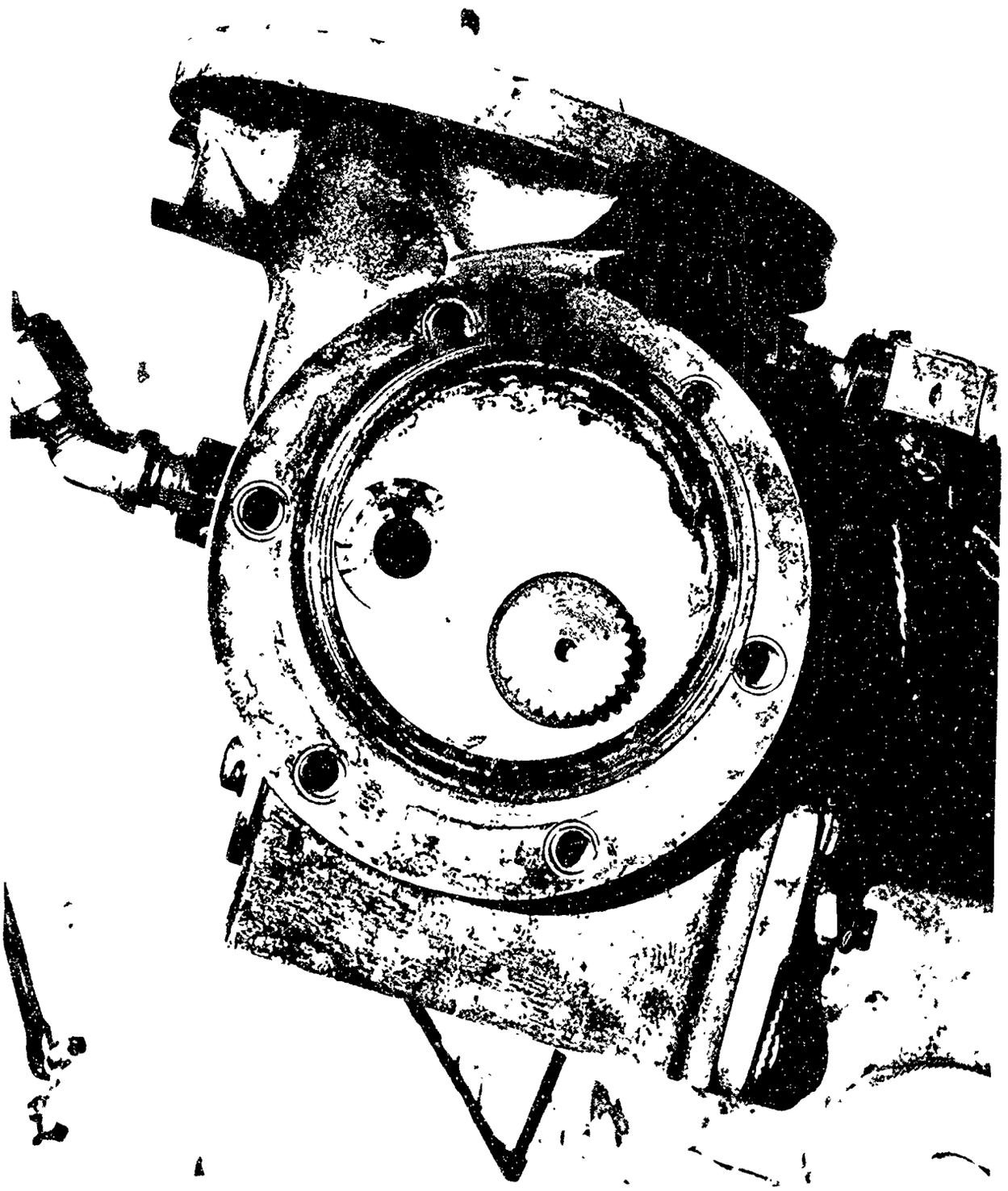


PHOTO No. 23
LO_2 BLADE VALVE DOWNSTREAM
SEAL WITH BLADE REMOVED

CONVAIR ASTRONAUTICS

PHOTO No. 24
LO_2 BLADE VALVE
DOWNSTEAM SEAL

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

PHOTO No. 25
LO_2 BLADE VALVE
UPSTREAM SEAL

~~CONFIDENTIAL~~

CONVAIR ASTRONAUTICS

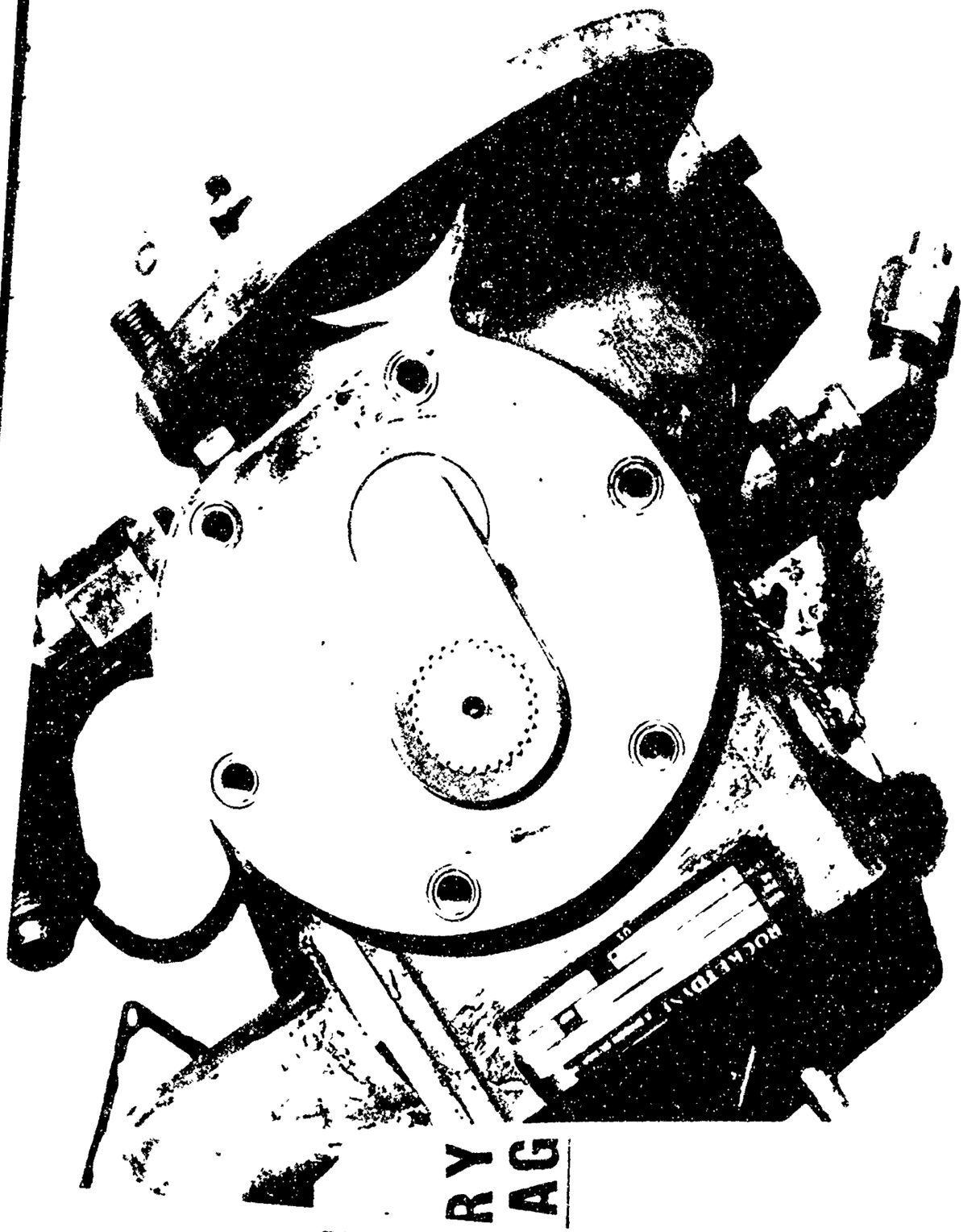


PHOTO No. 26
FUEL BLADE VALVE SHOWING
DOWNSTREAM SEAL INTACT

CONVAIR ASTRONAUTICS

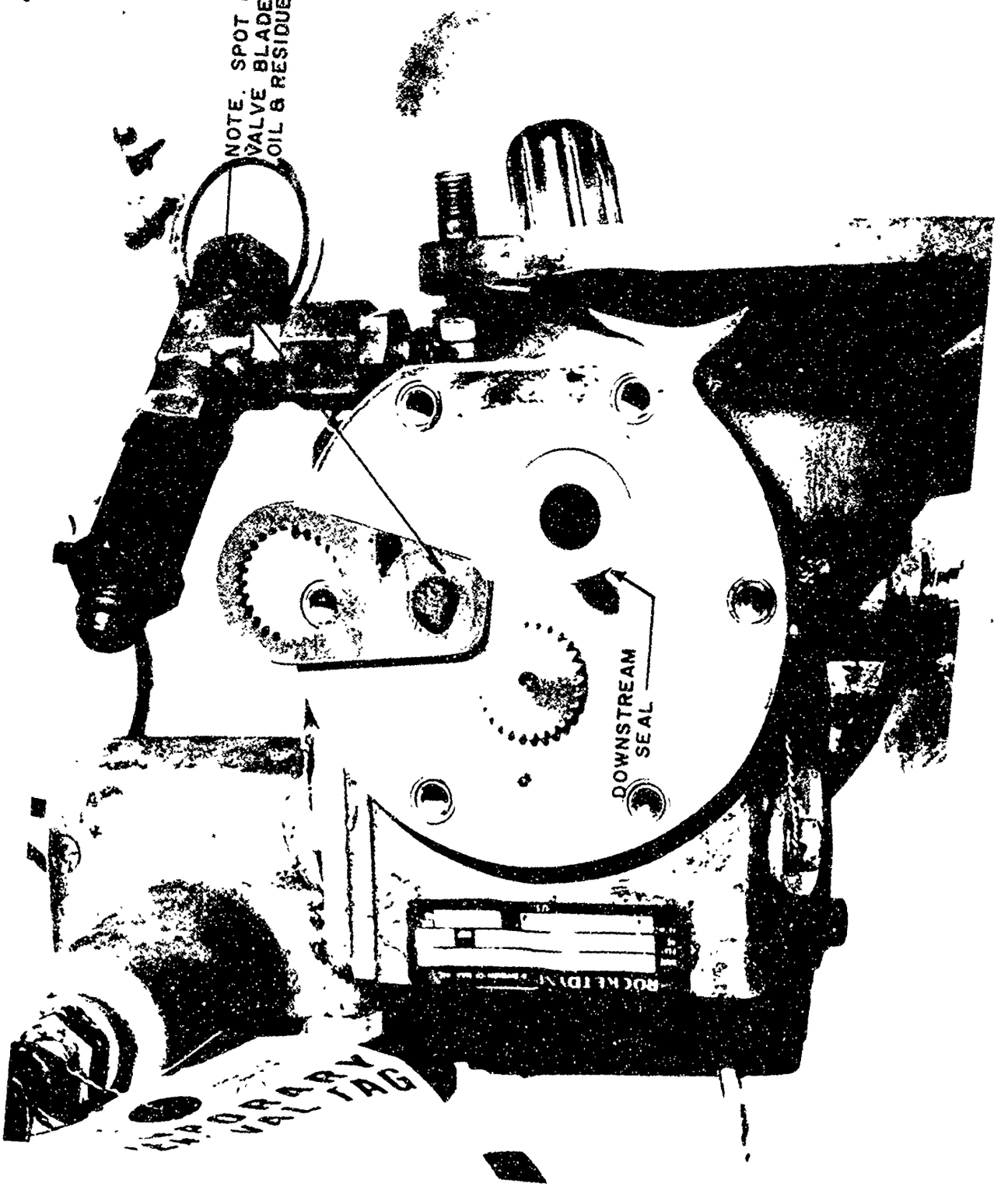


PHOTO No. 27
FUEL BLADE VALVE DOWNSTREAM SEAL
WITH BLADE REMOVED AND TURNED OVER

CONVAIR ASTRONAUTICS

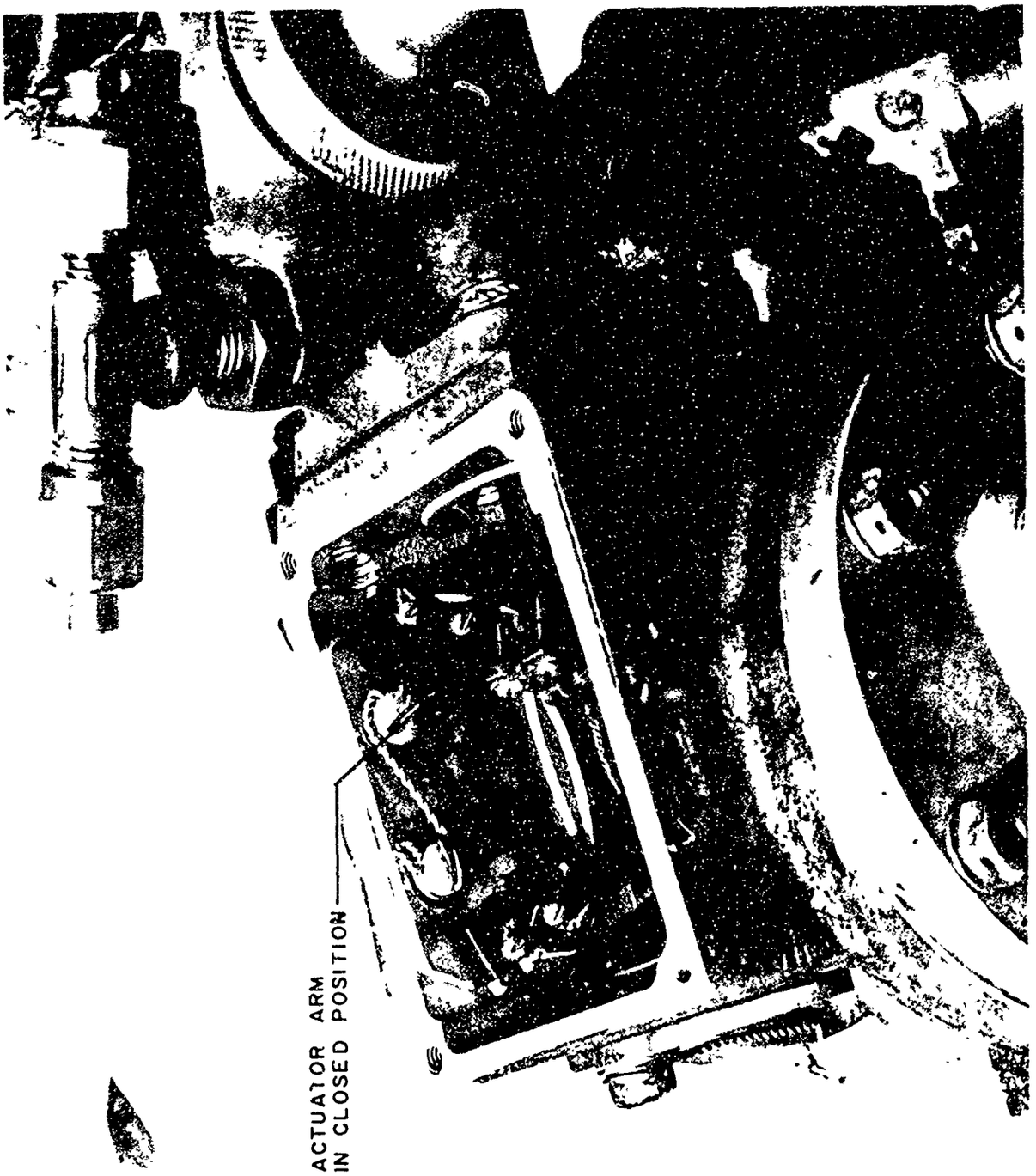


PHOTO No. 28
SUSTAINER GAS GENERATOR
PROPELLANT VALVE ASSEMBLY AS
DISASSEMBLED

APPENDIX F

ROCKETDYNE INVESTIGATION REPORT

S2-212-B4-01

LEM 844-1014
30 June 1958

TO: M. A. McClure, 596-42, Canoga

FROM: H. L. Conrad, 596-44, Canoga

SUBJECT: Accident Report Missile 1B (Engine S/N NA112001) at Sycamore Canyon Test Facility

At 16:38 hours on 18 June 1958, an explosion occurred in the turbine of the Sustainer engine (S/N NA222007) installed in Missile 1B as part of engine assembly S/N NA112001. This explosion caused considerable damage to the lower boattail structure, Booster chambers, Booster power package assembly, and the Sustainer engine assembly. Apparent cause of the explosion was failure of the Sustainer gas generator blade valve LO_2 seal at cutoff on the previous run.

The test in which the explosion occurred was the twelfth scheduled test on this missile and the fourth attempt to complete the first run of the Block II series of tests. The run was scheduled to be 100 seconds Booster, 194 seconds Sustainer, and 220.5 seconds of Vernier engine operation. Countdown and start appeared normal. Approximately 0.04 seconds after the gas generator igniters were signalled to fire, the explosion occurred. The ensuing fire was extinguished in approximately twelve (12) seconds by using water and CO_2.

Examination of Records

Examination of all records on this run and the previous run revealed the following:

1. Normal conditions prior to start and during the previous run.

2. On the previous run, the Sustainer gas generator probe had been burned off. Indications were that this had been caused by a cutoff temperature spike. (The chart was pegged at 1800°F). Momentary temperature spikes had occurred at cutoff on all previous runs. No pressure surge could be detected because the LO_2 injection manifold pressure and gas generator chamber pressure charts were inoperative. The gas generator system was examined externally for signs of high temperature prior to Run 12 and the results were negative.

Examination of Records (Continued)

3. About [illegible] seconds after cutoff on the previous run (approximately five feet of oscillograph paper), the LO_2 flowmeter indicated intermittent flow until the recorder was turned off.

4. The oscillograph trace indicated LO_2 flow to the Sustainer gas generator on this run prior to start.

5. The Sustainer gas generator discharge temperature chart was pegged down scale prior to start of this run

Examination of Hardware

Examination of the Sustainer gas g[illegible] after the explosion revealed a detonation or severe presssure surge had occurred in the LOX injector manifold. Further, the LO_2 seal was found to be shattered and the outline of the valve blade was impressed on the back-up plate for the seal.

Probable Cause

The probable cause and events leading up to the explosion is believed to be as follows:

1. The Sustainer gas generator LO_2 blade valve seal was shattered presumably at cutoff on the previous run by a sharp pressure surge or detonation in the LO_2 injector manifold of the gas generator as indicated by the following:

   a) The gas generator injector was [illegible] downward and the manifold was bowed upward.

   b) The gas generator blade valve was in the closed position.

   c) Temperature spike and possible pressure surge at cutoff on the previous run ([illegible] pressure information recorded to verify pressure surge).

   d) LO_2 leakage [illegible] previous run and prior to start of this run.

The [illegible] of the gas generator LO_2 [illegible] manifold [illegible] at cutoff. This situation [illegible] by the fact that the missile was in the process [illegible] cut-off was initiated.

2. The failed seal [illegible] fired.

Action Taken

The following action has been taken to minimize the possibility of this type of accident happening in the future:

1. A Field Service Bulletin has been written to re-emphasize ROCKETDYNE's recommended purge pressures and sequencing.

2. Recommend that cutoff temperature spikes on future tests be carefully evaluated to insure that no contamination of the gas generator LO_2 injector manifold has occurred.

3. Gas generator flowmeter and discharge temperature records be checked before and after each run for signs of LO_2 leakage.

4. The gas generator exhaust systems should be checked after LO_2 tanking for signs of LO_2 vapors.

A complete and detailed accident report is being prepared as a joint effort of Convair, Air Force, Ramo-Wooldridge and ROCKETDYNE representatives at Sycamore Canyon test site.

S/_____
H. L. Conrad,
Flight Support Unit
ATLAS Engines

APPROVED:

S/_____
H. Diem, Supervisor
Flight Support Unit
ATLAS Engines

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

FAILURE ANALYSIS REPORT

1. Report No.	2. Date of Analysis	3 Test No.	4A. Facility	4B Location
177666	23 July 1958		Rocketdyne	A8

5. Failed Item P/N	6. Failed Item S/N	7. Failed Item Name	8. F/1 Type or Model
9512-44185-51	P-086	Sus G.G. Assy	

9. HISTORY OF TROUBLE (NOTED FROM ITEM 26.1 ON F.C.D.R): On 18 June 1958, captive firing test No. 11 (TE-11) was performed at the Sycamore Canyon installation. After 2.34 seconds of mainstage start, the Gas Generator squibbs fired, followed by an explosion in the Turbine and Turbine Exhaust system. This explosion resulted in almost complete destruction of the sustainer engine. Extensive damage was also inflicted on the booster engine. In reviewing the test records on the sustainer engine, it was disclosed that a steady oxidizer flow was evident in the Gas Generator for 80 seconds prior to firing the Vernier squibbs. Flow rates recorded were .3 lbs/sec under tank head pressure and .51 lbs/sec at pressurization. Thermo-couple readings at the hot gas duct had dropped 30° below ambient temperature.

10. ANALYSIS PROCEDURE AND RESULTS: Disassembly of the Gas Generator disclosed the G.G. blade valve to be in the correct closed position and the following damaged detail parts were noted:

1. Shattered Oxidizer port seal.
2. Radially cracked pressure pad.
3. Oxidizer inlet cover place with gate impression at the edge of the pad cavity.
4. Dull (not abrasive) surface bearing the outline of the port seal bore on the Lox blade.
5. Partially burned silicone "O" ring.
6. Bits of grey ash and hard matter within the oxidizer cover cavity.
7. I.D. of the fuel seal locally burned in one area.

Further examination revealed that the injector plate yielded convexly on the normally flat surfaces. The injector face had bulged .068 inches at its maximum point. The flange surface took a permanent deflection of .020 inches. Spectro-analysis proved the grey ash and hard matter to be part of the burned silicone "O" ring. The oxidizer port seal was inspected under a magnifying instrument and no obvious wear or mars were evident.

11. CONCLUSIONS AS TO CAUSE OF FAILURE:
It is an established fact that the oxidizer seal in the G.G. blade valve was leaking prior to the major explosion of the engine. Conclusions that the seal was shattered by a detonation can only be derived from what evidence is presented in test records and past experience of similarly shattered oxidizer port seals. Test run prior to X day had shown intermittent G.G. oxidizer flow and a prolonged temperature spike after G.G. cutoff. Records, therefore, imply that the oxidizer port seal had failed in the previous firing after cutoff.

12. RECOMMENDATIONS FOR PREVENTING RECURRENCE AND ACTION TAKEN: R & D experience have had only 3 instances where oxidizer seals were shattered or cracked as a result of detonations internal to the G.G. Assy. or adjacent downstream hardware. Normal runs on this type G.G. have shown temperature spikes after cutoff (not to be common) except where purging is inadequate. Due to oxidizer seal leakage frequently being very low and seal cracking rare, no design change is contemplated in this area of the valve assembly. Malfunction studies will be extended should this frequency increase. A new purge procedure is under consideration.

B.G.SCOTT J. HOGSTAD